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THE TONKAWA FIELD, OKLAHOMA

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INTRODUCTION

GENERAL STATEMENT

Northern Oklahoma has held a prominent place as an oil-producing district during the past two years due to the development of the Tonkawa and Burbank fields. While closely connected geographically, these fields represent types very different in character. Tonkawa is of especial interest because of the number of producing sands, the high gravity of the oil, the close relation of production to structure, and the possibilities for deeper producing sands. The writers have been able to make a fairly detailed study of the Tonkawa field from the time the discovery well was started to the present time.

LOCATION

The Tonkawa field is located in Townships 24 and 25 North, Range 1 West, in Kay and Noble counties, Oklahoma (Fig. 1). Its location is near the center of the northern Oklahoma district, which includes fields in Kay, Noble, Grant, Garfield, western Osage, and Pawnee counties.

HISTORY AND DEVELOPMENT

The history of the Tonkawa field dates from June 29, 1921, when school land well No. 1 in the northeast corner of Sec. 16, T. 24 N.,

R. 1 W., was completed with an initial production of 850 barrels per day in the Tonkawa sand at a depth of 2,661 feet. The second

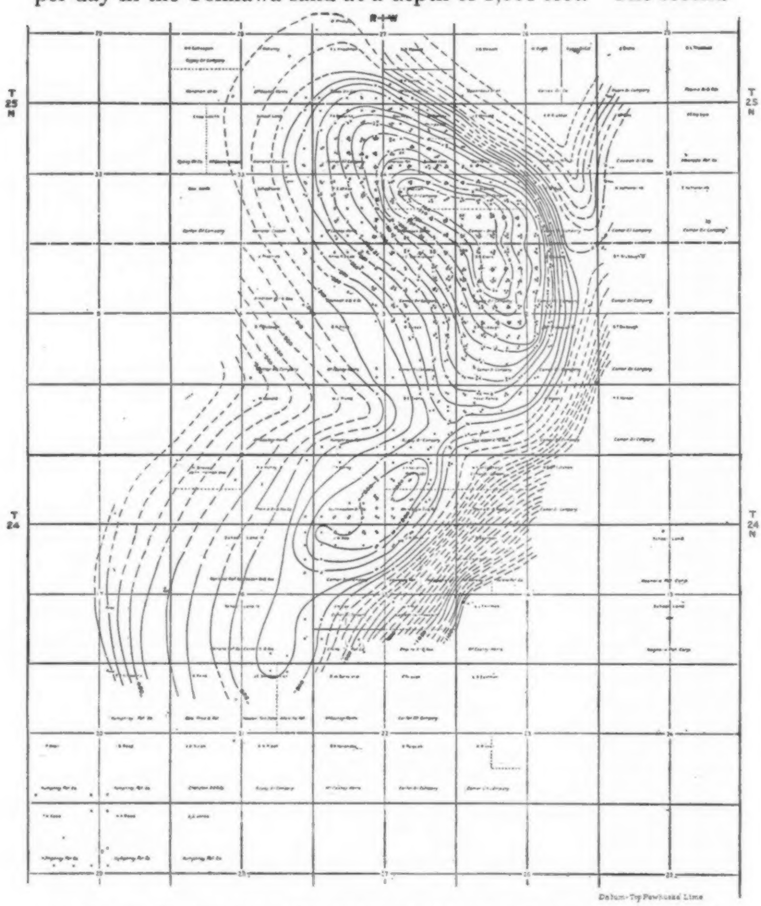


FIG. 1.—Structure map of the Tonkawa field based on the top of the Pawhuska limestone.

well (see No. 1, in the northwest corner Sec. 15, in the same township) was completed about three months later with an initial production of 3,300 barrels. The diagonal offset, Murray No. 1,

SW. cor. Sec. 10, started off soon after at the rate of 1,750 barrels per day.

The fourth completion was a dry hole offsetting the discovery well to the north. This came as a distinct surprise, since the first three wells had made exceptional production records up to this time. The difficulty of finding a satisfactory explanation was increased by the fact that structurally this dry hole was as well located as the south and east offsets. The log of the discovery well placed it 40 feet higher than the others but this was discounted as probably due to faulty measurement. Production from these first wells seemed to come from the very uppermost part of the Tonkawa sand. Samples from the Prairie dry hole show this comparatively thin productive zone to be tightly cemented, hence the failure which for a time led to the belief among operators that the field would be "spotted" and small in extent.

As development proceeded in the northern part of Sec. 15 and southern part of Sec. 10, dry holes were drilled in the NW. ¼ of Sec. 10 and the SW. ¼ of Sec. 3. The real importance of the Tonkawa field did not become apparent until almost a year later when Carmichael No. 1, in the SW. corner of the NE. ¼ of Sec. 3, was brought in for an 850-barrel well in the Lower Hoover sand. About that time the Slick gas well in the SW. corner of Sec. 35, T. 25 N., R. 1 W., reached a depth sufficient for correlation, and geologists were able to predict with confidence that a structure of unusual size had its apex near that location.

Development proceeded at a rapid rate during the last few months of 1922 and the first half of 1923. Drilling at first was done with standard tools, but when the intensive development of the north end of the field began, rotary methods were found much more satisfactory and came into use almost exclusively. By use of mud-laden fluid the gas encountered in shallow sands is handled and the oil sands are protected. Most of the wells are drilled to the top of the sand with the rotary and completed with cable tools.

SURFACE STRATIGRAPHY

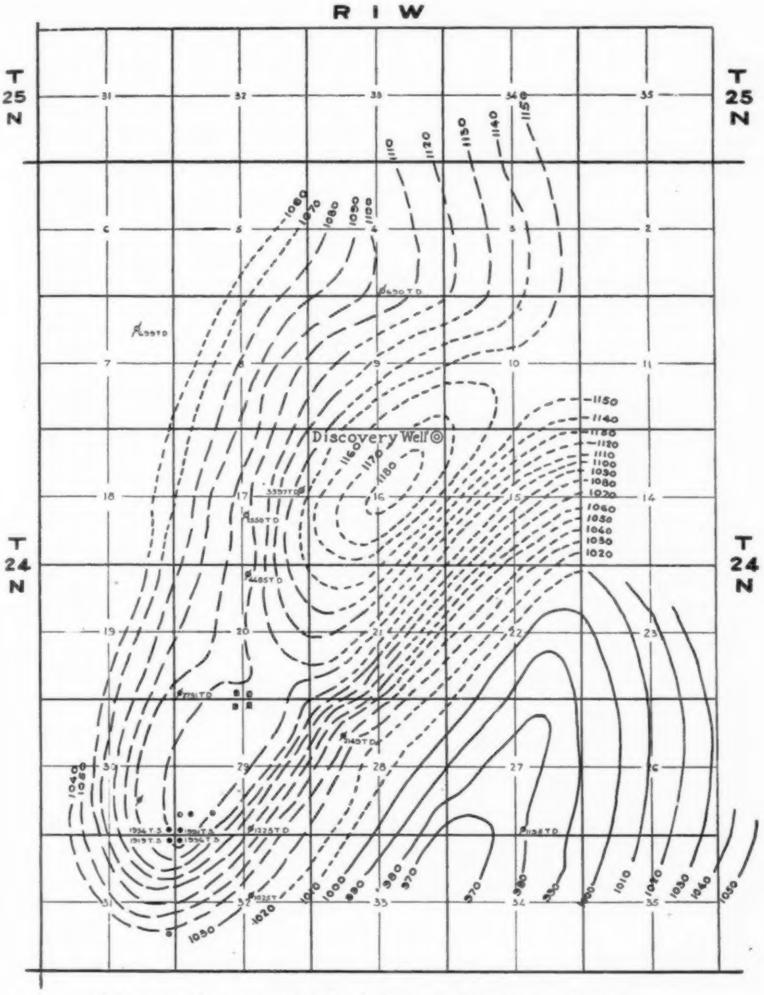
The surface formations within the Tonkawa field are red, blue, and gray shale with occasional beds of irregular shaly sandstones,

very thin beds of limestones, and mud stones. These beds are a part of the middle member of the Wellington formation, approximately 1,000 feet above the base of the Permian (top of the Foraker limestone).

In the Tonkawa district the Wellington has a total thickness of a little over 600 feet, and may be divided into three members, Lower, Middle, and Upper, with thicknesses of 250 feet, 240 feet, and 120 feet, respectively. The Lower is made up of gray and dark shales with brownish gray, greenish gray, and brown sandy shales of minor importance. The middle member is composed of predominately red shales with some browns and grays. A considerable number of these beds are sandy but very few may be classed as sandstones. The Upper Wellington is for the most part composed of dark gray shales with greenish and purplish shades prominent in the upper part. Calcareous beds are relatively conspicuous in this member as compared to the two lower members. The surface beds over the Tonkawa structure lie approximately 200 feet above the base of the Wellington formation. The interval used here between the base of the Wellington and the top of the Herington limestone is 70 feet. The top of the Wellington is taken as the sandstone outcropping in T. 25 N., R. 2 W., and the western part of T. 26 N., R. 2 W. These limits of the Wellington, however, may be subject to revision. The following depths from the surface, over the higher part of the structure, to the first three prominent limestones below the surface may be checked in well logs: Herington, 270 feet; Winfield, 330 feet; Fort Riley, 500 feet.

STRUCTURE

Evidence of structure from surface outcrops is almost entirely lacking over the area included in and immediately surrounding the Tonkawa field. This is especially true of the north end, which has been proved the highest part of the structure and the most productive. The preliminary structure map is a reproduction of the structure responsible for the drilling of the discovery well (Fig. 2). This combination of surface and subsurface mapping gave evidence of a structure of considerable size, but its exact position and extent could not be determined until development worked northward.



Tonkawa Structure as mapped when location was made for discovery well.

Surface Contours: ——— *Sub-Surface Contours:* — — *Hypothetical Contours:* ----

FIG. 2

Various horizons may be used for subsurface structure mapping with essentially similar results. The Pawhuska lime is considered the best limestone marker while the Lower Hoover is probably the best sand although the Tonkawa sand is used on account of its position and importance. The value of the latter is offset by the very indefinite character of the upper part of this sand.

A decrease in the thickness of shale formations over the Tonkawa structure is noticeable, although not as prominent as at Blackwell. In this respect Tonkawa is more comparable to the Ponca City field. A maximum divergence of about 80 feet is present from the Herington limestone to the Tonkawa sand. The maximum divergence at Ponca City from the Herington to the 2,650-foot or Layton sand is approximately 100 feet, while a divergence of 250 feet exists between the Herington and the top of the Mississippi lime and 400 feet between the Herington and the base of the Mississippi lime. At Blackwell there is a known divergence between the Herington and the base of the "Oswego" big lime series of 300 feet and between the Herington and the Stalnaker (Tonkawa) sand of 200 feet. In all probability divergence will increase below the Tonkawa sand at Tonkawa and known sands may be expected at shallower depths over the higher part of the structure than records of surrounding deep wells would indicate.

SUBSURFACE STRATIGRAPHY

Subsurface correlations within the Tonkawa field are made comparatively simple by the persistence and regularity of several key beds. Where good records are kept dependable correlations may be made when a well has reached a depth of 400 or 500 feet. The Winfield and Herington limestones, the overlying red shale of the Upper Marion, and the gray shale-anhydrite series of the Lower Wellington furnish a sequence easily recognized. The anhydrite beds are usually recorded as limes by drillers. The Fort Riley limestone is quite often helpful in determining shallow correlations.

The 200- or 250-foot interval between the Fort Riley and the series of gas sands at the base of the Permian is composed largely of red shale with a few unimportant limestones. The shallow gas horizon lies at the base of the Permian, or at least at the base

of the red Permian. The contact between Permian and Pennsylvanian is placed somewhere between the base of the gas sand series

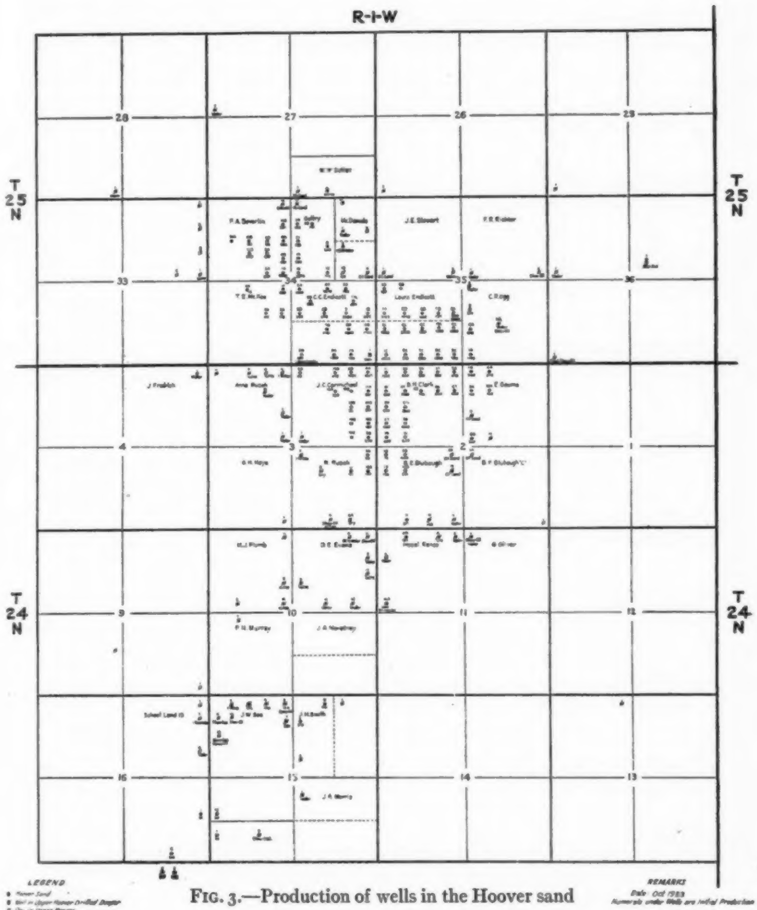


Fig. 3.—Production of wells in the Hoover sand

and the top of the prominent lime found at a depth of about 1,000 feet near the top of the structure and at about 1,100 feet at the south end of the field.

This limestone is known as the Foraker because of its excellent correlation by means of well logs with the known Foraker outcropping in the Burbank field and because of the abundance of

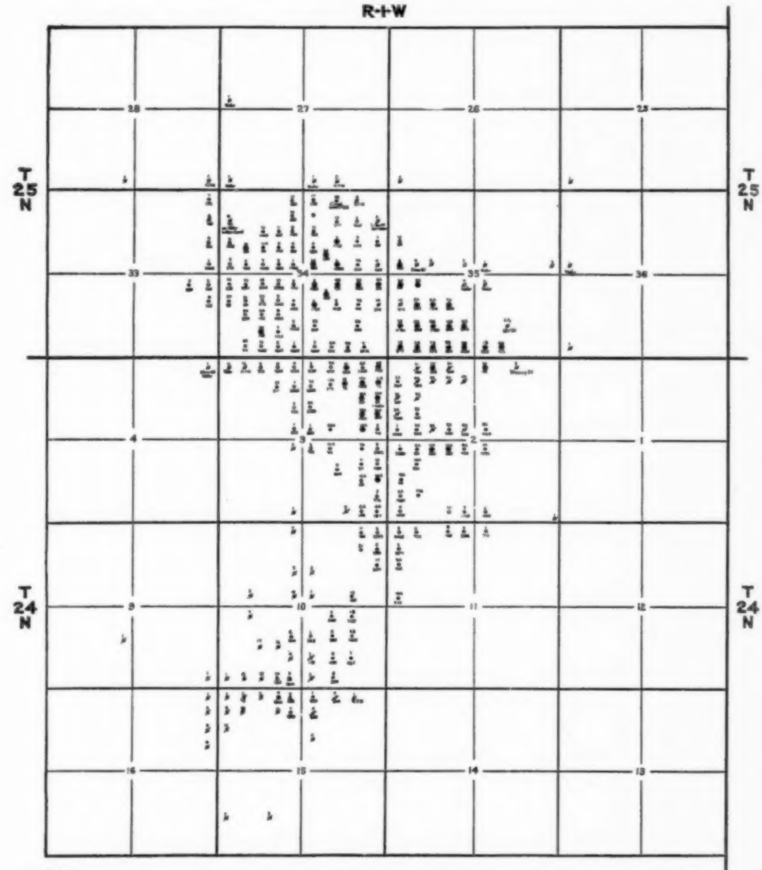


FIG. 4.—Production of wells in the Lower Hoover and Endicott sands.

Fusulina found in well cuttings. While this latter fact by no means offers final proof that this lime is Foraker it does lend considerable support to the well-log correlation (Plate II).

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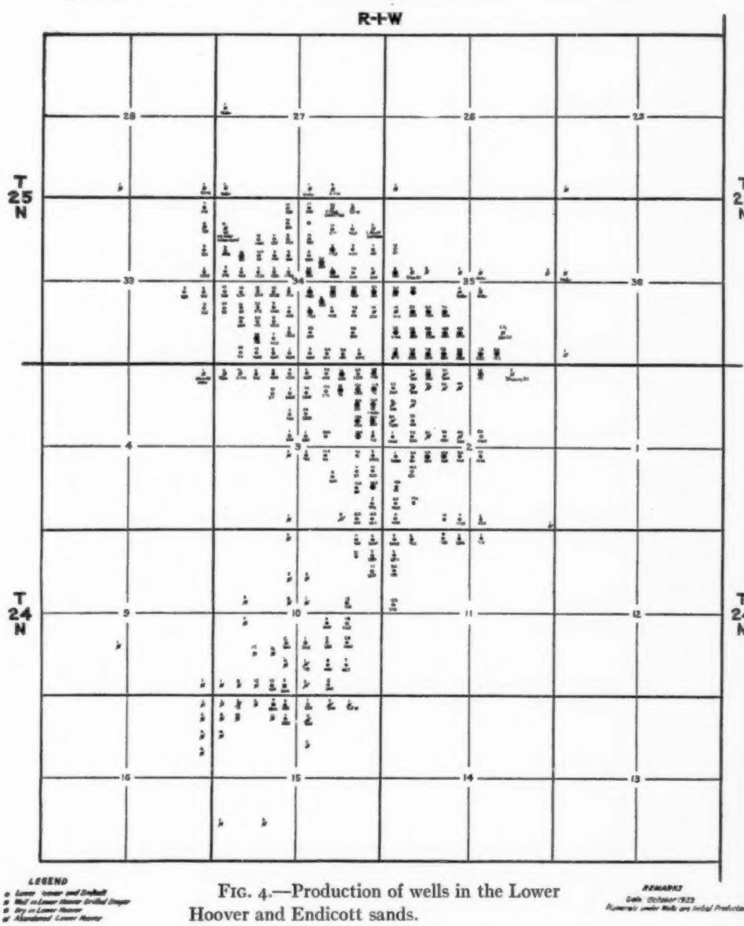

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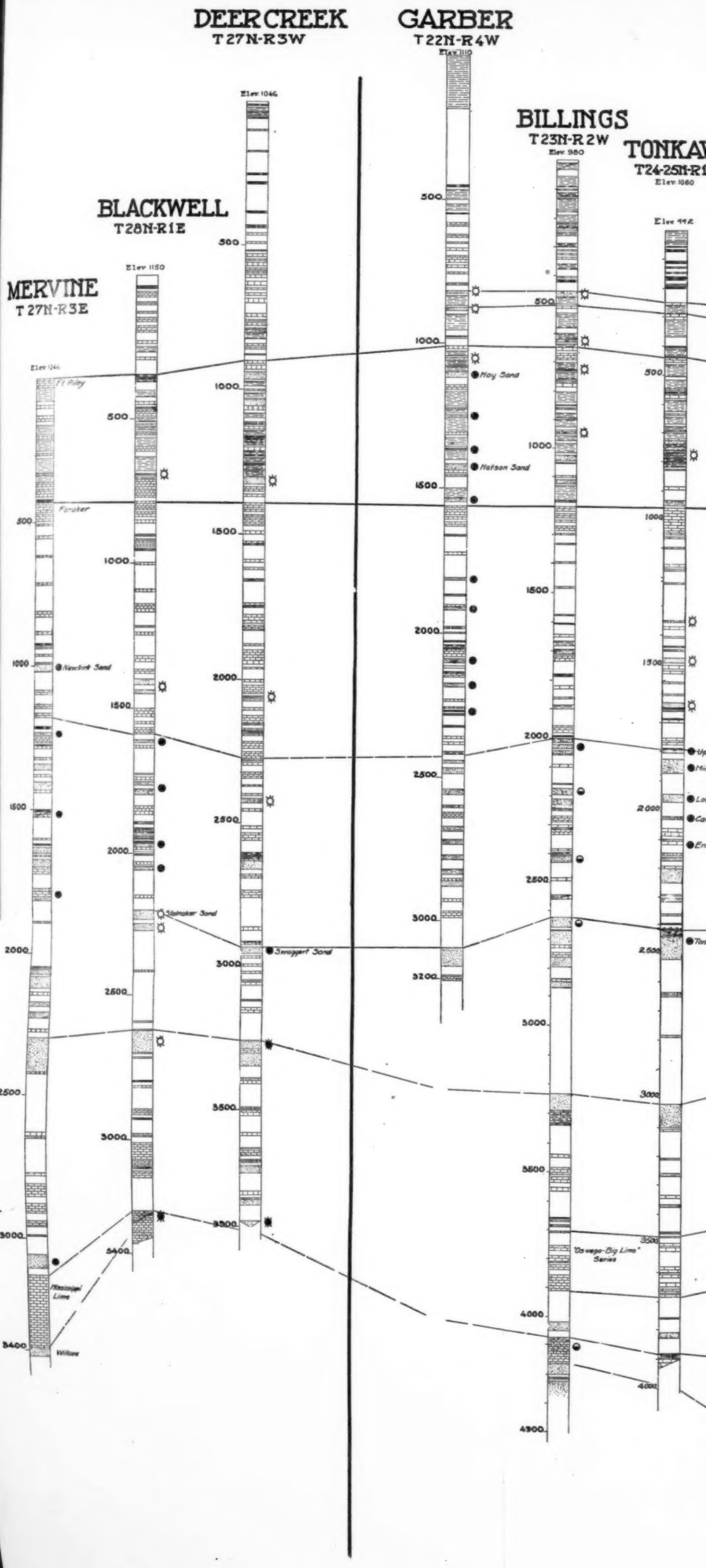
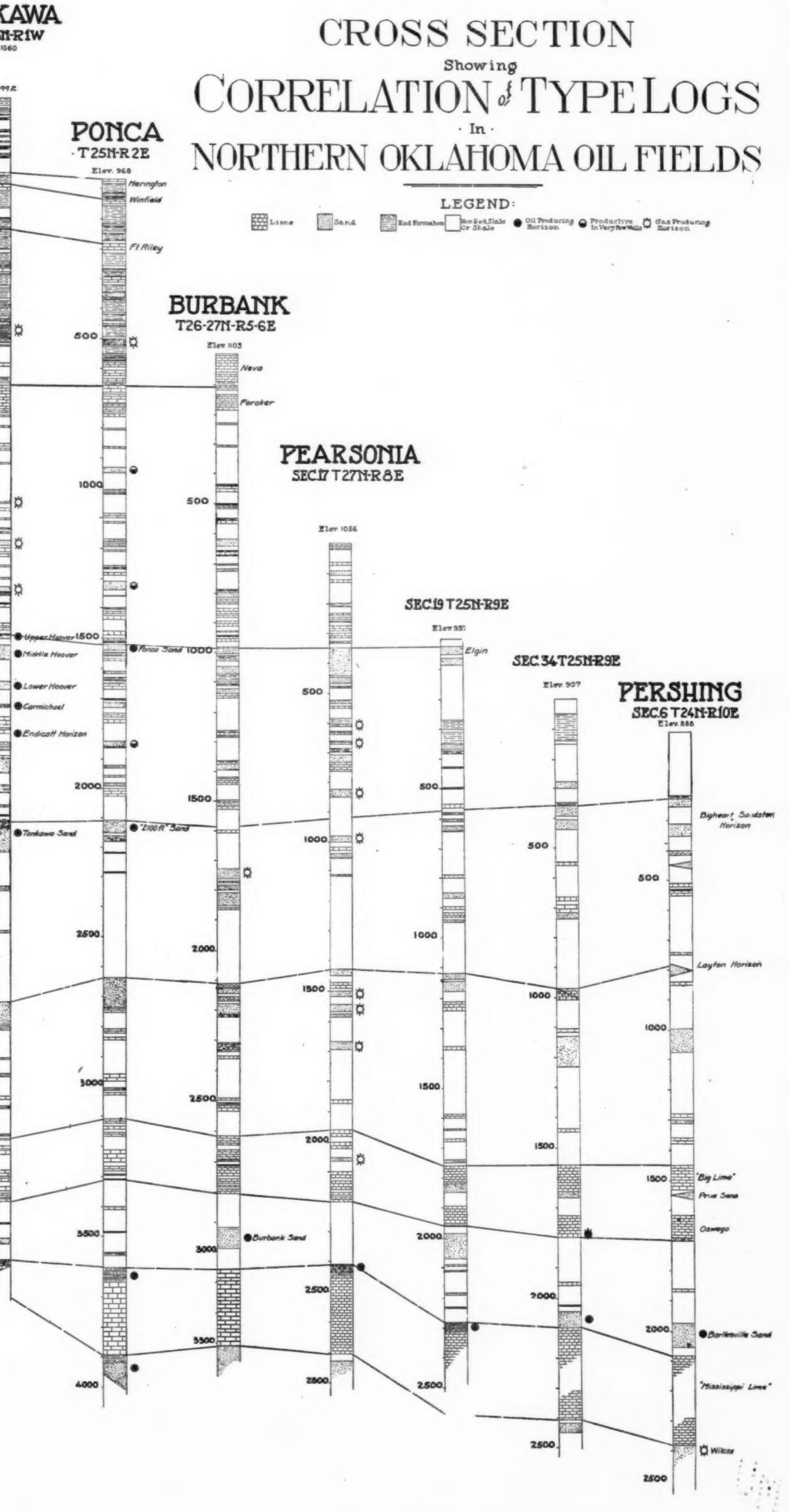

DEER CREEK
T27N-R3W
GARBER
T22N-R4W
BILLINGS
T23N-R2W
TONKA
T24-25N-R1
BLACKWELL
T28N-R1E
MERVINE
T27N-R3E
Ft. Riley
Foraker
Newkirk Sand
Hoy Sand
Hotson Sand
Stalnaker Sand
Sm... Sand
"Oswego-Big Lime" Series
Mississippi Lime
Wilcox

CROSS SECTION Showing CORRELATION of TYPE LOGS In NORTHERN OKLAHOMA OIL FIELDS



R-I-W

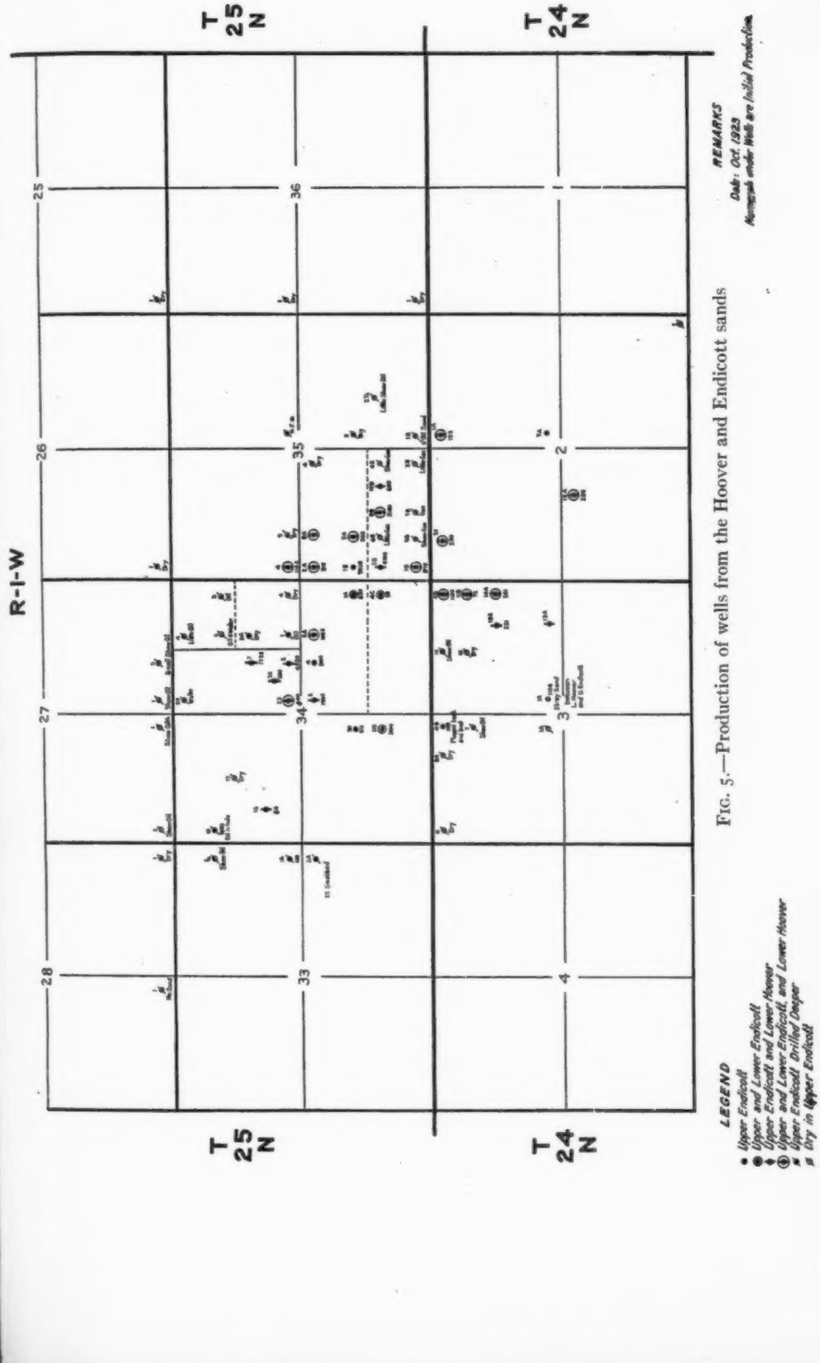


FIG. 5.—Production of wells from the Hoover and Endicott sands

The first 400 feet below the Foraker is composed chiefly of gray or blue shales. The next 400 feet below contains several lime members and three gas sands. The lime about 800 feet below the Foraker and just above the Hoover sand series is probably the best key horizon for structure mapping. It is definitely correlated with a part of the Pawhuska limestone series of Osage County as described in *U. S. Geol. Survey Bulletin 686*, and is commonly called the "Pawhuska lime" in the field.

The series of sands below the Pawhuska, 150 to 200 feet in thickness, is correlated with the Elgin sand series of Osage County. The upper sand is called Upper Hoover (Fig. 4) after the main producing horizon of the Billings field. The Lower Hoover, some 150 feet below, received its name by reason of its being generally considered a part of the series including the better-known Hoover sand. The Middle Hoover sand usually carries water but has produced in a few wells in the north end of the field. On account of the variable character of the upper and middle sands they are usually taken together as the Upper Hoover. The necessity for special sand names was felt among scouts and geologists when development shifted from the older south end of the field to the north end, which is considerably higher structurally. Reference to the 2,000-foot sand meant either Upper or Lower Hoover, depending on the part of the field intended.

The next two producing horizons are here referred to as Endicott sands, after the farm name on which they were first productive. The Upper Endicott (Fig. 5) lies about 150 feet below the Lower Hoover and the Lower Endicott (Fig. 6) some 50 to 100 feet below the Upper. These sands are only productive on the main structure, where combination wells are often produced in connection with the Lower Hoover.

The Tonkawa sand (Fig. 7) is the most reliable producing horizon of the field. It is found at depths ranging from a little less than 2,500 feet to a little over 2,600 feet and has a thickness of 75 to 100 feet. At the south end of the field near the discovery well only the upper part of the sand was productive, the lower part carrying water. Over the north end, oil is found in zones throughout almost the entire thickness of the sand. The bottom part of the

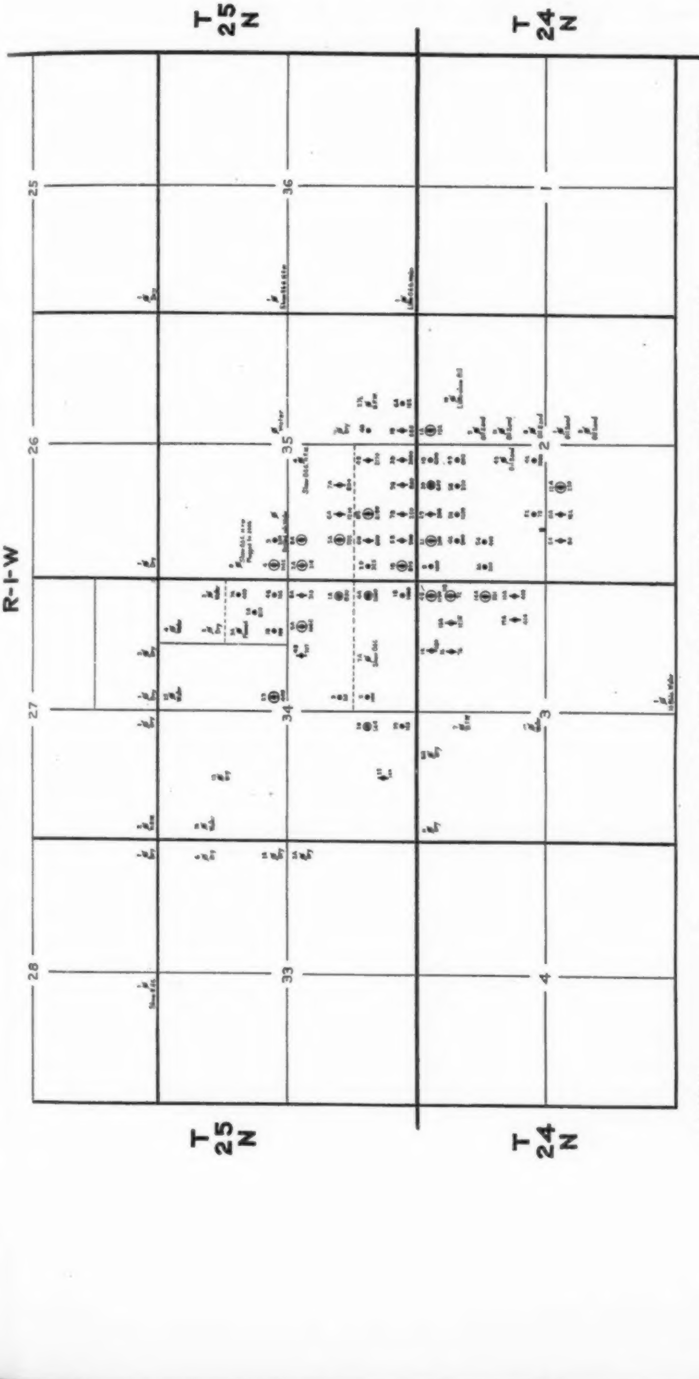


FIG. 6.—Production of wells from the Hoover and Endicott sands

sand usually carries a little oil but in the heart of the field is free from water.

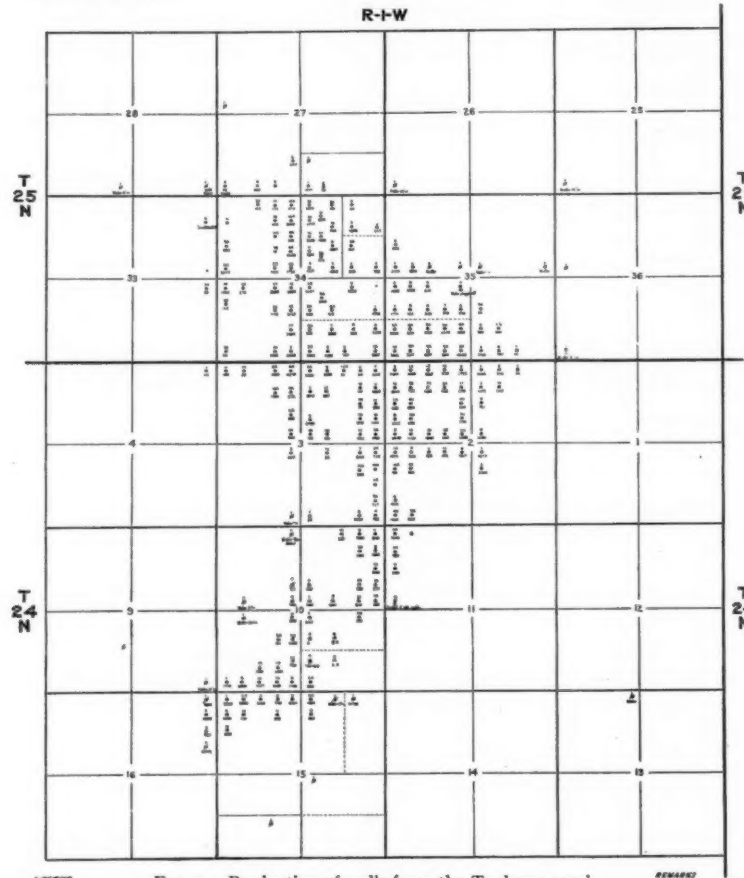


FIG. 7.—Production of wells from the Tonkawa sand

POSSIBILITIES FOR DEEPER PRODUCTION

Within the limits of the field, which are now well defined, there have been no horizons tested below the Tonkawa sand. A few edge wells were drilled to the sand, found at a depth of around 3,200 feet.

One well in the northeast of Sec. 35 found a stray sand at 2,800 that showed for 10 barrels. The 3,200-foot sand may be expected over the higher part of the structure at a depth of around 3,050 feet. This sand is one of the most persistent and regular found in northern Oklahoma. It is correlated with the 2,600-foot gas sand of Blackwell, the 2,650-foot sand at Ponca, the Watchorn oil sand at Morrison, and the 3,300-foot oil and gas sand at Deer Creek. It occupies approximately the same position stratigraphically as the Layton sand of the Yale-Cushing area. The character of this sand, its thickness and position in the section over a structure such as that at Tonkawa, give support to the belief that this sand should be productive. This statement is made in spite of the fact that at Ponca this sand is not productive and at Blackwell produces only gas.

The "Oswego" big lime series may be passed with little comment. While many wells in this area report show in this zone, with the exception of the 3,100-foot production recently discovered in Sec. 16, T. 27 N., R. 1 W., none have made commercial producers. This producing horizon is in the upper part of the "Oswego" big lime series. In the Kirtpatrick deep test in Sec. 20, T. 24 N., R. 1 W., a 40-foot sand was reported in the log at 4,100 feet. This sand is between the "Oswego" and Mississippi limes and occupies the position of the Burbank sand or the Prue sand of the Cleveland area in the southern Osage. If this sand is present over the Tonkawa structure it has very good chances for production.

The top of the Mississippi lime should be reached around 3,900 feet. If this lime is present and has something like its normal thickness as in the Ponca field, production may be expected in the upper part. Production in this chert or "chat" member of the Mississippi lime may be better on the flanks than on the very highest parts of the structure.

There is a possibility or even probability that the Mississippi lime may be entirely removed from the higher part of the Tonkawa structure. There is little doubt but that this is the case at Blackwell, where the 3,300–3,400-foot Wilcox production is found surprisingly high. The Washburn 11-A deep test in the Billings field found production about 4,160, which very likely is Wilcox. The

depth to the Wilcox in the Tonkawa field is especially difficult to estimate. In the Ponca field the interval from the 2,650-foot sand to the Wilcox sand is 1,200 to 1,300 feet. This same interval

TABLE I

AVERAGE DAILY PRODUCTION BY MONTHS

Month	No. Wells	Average Daily Production	Average Daily Production per Well
	1921		
July	1	817	817
August	1	740	740
September	1	744	744
October	1	638	638
November	3	3,806	1,268
December	3	3,088	1,029
	1922		
January	4	3,313	828
February	5	3,971	794
March	5	3,142	628
April	11	4,238	385
May	15	8,365	557
June	20	8,879	444
July	18	7,811	434
August	27	9,673	358
September	37	15,545	420
October	49	16,967	346
November	56	19,867	355
December	66	27,887	423
	1923		
January	81	38,797	479
February	113	61,883	547
March	147	85,925	584
April	206	97,436	473
May	272	111,907	485
June	354	106,586	301
July	438	99,071	226
August	486	77,477	159
September	535	57,613	108
October	658	51,980	91

applied to Tonkawa would place the Wilcox at a depth of about 4,300 feet. But assuming conditions similar to Blackwell, the Wilcox may be expected around 3,900 or 4,000 feet.

PRODUCTION

Up to October, 1923, one 80-acre tract in the south end of the field has produced approximately 20,000 barrels per acre, practically all of which was from the Tonkawa sand. One of the best 80-acre tracts in the northern end of the field has, up to the same month, produced around 27,000 barrels per acre, all sands included.

TABLE II

YIELD PER BARREL OF TONKAWA CRUDE

Product	Gallons	Percentage
New navy gasoline	19.32	46
41°–42° Baumé kerosene	13.36	8
32°–34° Baumé gas oil	3.36	27
24°–28° fuel oil	2.10	5
Lubricating oil	2.10	5
Wax	0.42	1
Coke	1.26	3
Loss	2.10	5

For information on casing methods, analyses of waters, and distillation tests on oils from different sands, the reader is referred to "Petroleum Engineering in the Tonkawa Oil Field," by J. S. Ross of the Bureau of Mines.

THE TONKAWA OIL AND GAS FIELD, OKLAHOMA[1]

J. F. HOSTERMAN
Tulsa, Oklahoma

INTRODUCTION

The Tonkawa field, with a daily average production for the week ending May 23, 1923, of 111,223 barrels of 43° B. gravity oil from 267 wells, ranks as the greatest producer of such high gravity oil in the United States. The remarkable initial production of wells, the high gravity of the oil, the numerous oil-yielding horizons, and the fact that this is the only pool in northern Oklahoma where the main producing area is being drilled with rotary tools combine to make the field of unusual interest. Due to the many problems encountered in drilling, the field has been studied closely, and measures have been taken to protect the sands and insure efficient development.

The field lies in Ts. 24–25 N., R. 1 W., Kay and Noble counties, Oklahoma, 6 miles south of the city of Tonkawa. Figure 1 shows the location of Tonkawa and its relation to other fields in the same general area. The producing area comprises approximately 5 square miles lying in Sections 2, 3, 10, 11, 15, and 16 of T. 24 N., and Sections 27, 33, 34, 35, and 26 of T. 25 N., R. 1 W. The greatest production centers at the intersection of Sections 2, 3, 34, and 35.

The discovery well, located in the northeast corner of Section 16, T. 24 N., R. 1 W., was drilled by the Marland Refining Company and Cosden Oil and Gas Company and completed on June 29, 1921. Due to lack of pipe-line connections and tankage, a 24-hour gauge was not obtained until the eighteenth of July, when the well produced 1,000 barrels, dropping to 750 barrels on the nineteenth. This well, produced from the Tonkawa sand, found from 2,658 to 2,660 feet. Following the completion of this well, a number of dry holes were drilled, one being the north offset to the discovery well,

[1]Published by permission of the Amerada Petroleum Corporation, Tulsa, Oklahoma.

and it was not until a year later that intensive drilling was started. The Comar Oil Company extended the field to the northeast on their Carmichael lease at this time. The introduction of the rotary

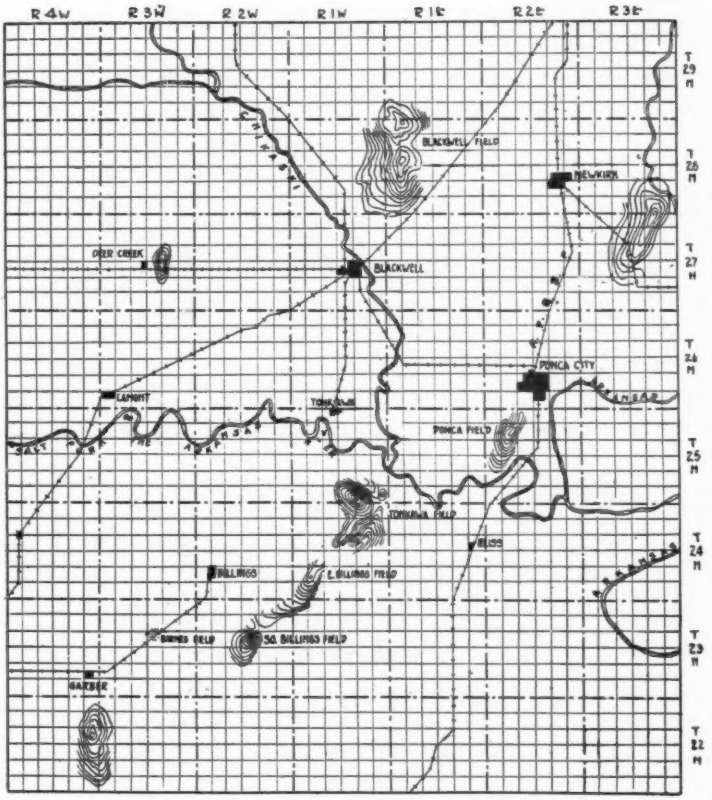


FIG. 1.—Sketch showing fields near Tonkawa

system of drilling and the demand for high gravity oil led to the rapid development of the field.

Elevations in the field range from 951 to 1,060 feet above sea-level. The southern part of the field is in the typical rolling prairie land of this general area. A number of wells in the northern

extremity of the field are located on the flood plain of the Salt Fork of Arkansas River. Small meandering tributaries of the Salt Fork drain the area.

STRATIGRAPHY

GENERAL STATEMENT

With the exception of the terrace deposits along the Salt Fork of Arkansas River, the surface formations and the upper subsurface formations are of Permian age. Pennsylvanian strata, comformably beneath the Permian, lie at depths ranging from 980 to 1,100 feet in different parts of the field. It is generally believed that all of the present oil production is derived from sands of Pennsylvanian age. Gas is found in several sands of Permian age. Sands productive at Tonkawa have been correlated with the producing sands of Deer Creek, Blackwell, Newkirk, Billings, and Ponca City fields.

FORMATIONS EXPOSED

Terrace deposits.—Along the Salt Fork of Arkansas River, a considerable thickness of sand and silt overlies the Permian formations. Terrace deposits are well defined along the south side of the river at Tonkawa and extend across the north side of the field.

Wellington shale.—The Wellington shale is the highest Permian formation exposed in the field. It comprises blue, green, yellow, and brown shales with a few impure limestones or "mudstones." This series is important in making correlations of logs of shallow test holes, drilled before the field was developed.

FORMATIONS NOT EXPOSED

Herington limestone.—The Herington limestone is often very difficult to detect in logs of wells in the field, but it makes an escarpment along Arkansas River near Ponca City. Northeast of Ponca City, 15 miles northeast of the field, it is 18 to 20 feet thick, massive below and thin-bedded above. It is a good marker in wells drilled with cable tools.

Uncas shale and Winfield limestone.—Underlying the Herington, the Uncas shale, about 60 feet thick, comprises blue, red, and brown shales and clays with some brown to red sandstones. This shale is underlain by the Winfield limestone, which is about

15 feet thick at its outcrop northeast of Ponca City. The Winfield limestone is found at depths of 300 to 400 feet at Tonkawa.

The 800-foot gas sand zone.—About 500 feet below the Winfield limestone, and presumably near the base of the Permian, there is a zone of gas- and water-sands about 175 feet in thickness. This zone, although it consists of irregular lenticular sands, is found in all wells throughout the field. The upper sands of this zone carry the gas which supplies the field while the lower sands invariably carry water. Below this series there is about 120 feet of blue shale underlain by a red bed 10 to 40 feet in thickness. This red bed overlies the Foraker limestone which is of Pennsylvanian age. The line between Permian and Pennsylvanian in northern Oklahoma has never been conclusively established. Beede puts it at the Neva limestone.[1]

Foraker limestone.—A limestone bed averaging 110 feet in thickness is found at depths ranging from 980 to 1,100 feet and has been correlated with the Foraker limestone of Osage county, Oklahoma. Cable-tool drillers log this limestone as a hard, gray, fine-grained limestone with minor beds of blue shale. Rotary drillers, however, have described it in various terms ranging from "shale with lime shells" to extremely hard limestone varying in thickness from 100 to 500 feet. In wells drilled with cable tools, where the depth to the top of the limestone has been measured with some degree of accuracy, this limestone makes a very good marker.

The 1400-foot gas sand.—The Foraker limestone is underlain by shales and limestones with a few persistent sands. The upper part of this series consists mainly of blue shale; limestones predominate in the lower part. The sands are found near the base of this series. The first sand is approximately 400 feet below the top of the Foraker limestone at depths of 1,450 to 1,550 feet and is from 30 to 50 feet in thickness. This sand carries considerable gas, wells yielding from 3 to 15 million cubic feet, with a rock pressure varying from 400 to 600 pounds per square inch.

Newkirk sand.—The Newkirk sand is found approximately 175 feet below the 1,400-foot gas sand and often carries both water and

[1] "The Neva Limestone of Northern Oklahoma," J. W. Beede, *Okla. Geol. Sur. Bull. No. 21.*

gas. Where the gas is entirely absent, the sand carries water under high pressure. Pennok Oil Co. No. 1 Endicott, SE. cor. SE. ¼ Sec. 34, T. 25 N., R. 1 W., the largest gas well in the field, produced from this horizon. The initial open flow production of this well was 74,000,000 cubic feet of gas with a rock pressure of 650 pounds per square inch.

Pawhuska limestone.—The Pawhuska limestone, 10 to 40 feet in thickness, lies 800 feet below the top of the Foraker limestone. While this interval between the top of the Foraker and the top of the Pawhuska remains fairly constant on the top of the structure and for some distance down the flanks, it is considerably greater on the steep northeast flank of the anticline. In Amerada Petroleum Corporation's No. 1 Richter, SE. cor. NE. ¼ Sec. 35, T. 25 N., R. 1 W., the interval is 830 feet, and in Cosden No. 1 Bills, SW cor. NW. ¼ Sec. 36, T. 25 N., R. 1 W., the interval is 835 feet.

Hoover sand zone—Elgin sand.—The Hoover sand zone, 150 to 230 feet in thickness, underlies the Pawhuska limestone. This zone has been divided into the Upper, Middle, and Lower Hoover sands, interbedded by blue shale and a few thin limestones. The Upper and Middle sands are very closely related, the Middle sand often being logged as the base of the Upper sand. The Upper and Lower sands yield oil while the Middle sand always carries water.

While the Upper Hoover sand is a fairly productive horizon on the higher part of the structure, in places it is either lacking or rests directly on the Middle Hoover sand. It is found at depths varying from 1,800 to 2,000 feet and is from 15 to 50 feet in thickness. The interval from the top of the Pawhuska limestone ranges from 10 to 50 feet, the average being 43 feet. This interval increases down the flanks of the anticline. The Amerada Petroleum Corporation No. 1 Sipe, center SW. ¼ of the NE. ¼ Sec. 36, T. 25 N., R. 1 W., a northeast extension to the field, was completed as a 40-barrel well in this sand. In several dry holes drilled between this well and the field the Upper Hoover sand was either dry or carried water with no show of oil.

The Middle Hoover sand averages 40 feet in thickness and invariably carries water, although a few wells on the T. B. Slick lease seem to be producing oil from this sand. The interval from

the top of the Pawhuska limestone to the top of the Middle Hoover sand averages 80 feet, increasing, as in the case of the Upper Hoover, on the flanks of the anticline.

The Lower Hoover sand is found at depths ranging from 1,950 to 2,150 feet, about 200 feet below the top of the Pawhuska limestone. It is separated from the overlying sand by 40 to 60 feet of blue shale. The sand varies in thickness from 15 to 50 feet and is thinnest on the flanks of the structure. Next to the Tonkawa sand the Lower Hoover sand is the best producing horizon in the field. Initial production from single wells in this sand reaches as high as 2,750 barrels. Due to the rapid decrease in the gas pressure in this sand, output has declined and will probably end before that from wells in the deeper sands.

Carmichael sand.—This sand, named from the lease on which it was first productive, was found 70 feet below the top of the Lower Hoover sand. The original well in this sand, Comar Oil Company No. 1-A Carmichael, SW. cor. NE. $\frac{1}{4}$ Sec. 3, T. 24 N., R. 1 W., came in with an initial production of 1,105 barrels from the sand at 2,170 to 2,189 feet. A number of wells have been drilled with cable tools through this horizon without finding the sand. There is a difference of opinion among operators in the field concerning the exact nature of this horizon. Some think that it is a sandy limestone or true sand while others think that it is a porous limestone. Core samples obtained from some wells at this horizon show porous limestone, while samples from wells producing from this horizon show the presence of sand. A review of developments, September 1, 1923, shows that 15 wells have found a sand 70 to 100 feet below the top of the Lower Hoover sand. In these wells the average sand thickness is 19 feet. Few of them have been commercial producers in this sand.

Endicott sand series.—The Endicott sands were found when wells which obtained oil in the Lower Hoover sand were deepened in hope of getting larger wells in the Carmichael sand. The Comar Oil Company in deepening their No. 1-B Laura Endicott, SW. cor. NW. $\frac{1}{4}$ SW. $\frac{1}{4}$ Sec. 35, T. 25 N., R. 1 W., found a sand 140 feet below the top of the Lower Hoover sand, from the first 8 feet of which the initial production was 7,000 barrels. This sand

has been named the Upper Endicott sand. By September 1, 1923, 35 wells had found this sand, although it was not everywhere commercially productive. It was found at an average depth of 141 feet below the top of the Lower Hoover sand, and its average thickness was 19 feet. No water has been reported in this sand.

The Middle Endicott sand was first found productive in Pennok Oil Company's No. 5 E. E. Endicott, NW. cor. SW. ¼ SE. ¼ Sec. 34, T. 25 N., R. 1 W. In this well the interval below the top of the Lower Hoover sand is 212 feet, the sand occurring at 2,190 to 2,219 feet. At least 47 wells have penetrated this sand, the average interval being 204 feet, with 30 feet of sand. It is interesting to note that Pennok Oil Company No. 7 Endicott, NE. cor. NW. ¼ SE. ¼ Sec. 34, T. 25 N., R. 1 W., was dry in this sand and abandoned at 2,247 feet.

The Lower Endicott sand, with an average thickness of 35 feet, lies about 240 feet below the top of the Lower Hoover sand and is the equivalent of the intermediate water sand mentioned in the United States Bureau of Mines report on the field.[1] To date, November 1, 1923, this sand has not yielded oil.

Tonkawa sand.—The Tonkawa sand, commonly called the "2,600-foot sand," was the first sand in the field to yield oil and is now the best producing Horizon. The oil in the Tonkawa sand extends farther down the flanks of the fold than that in the upper sands, and from all indications will hold up better than the other sands. In the northern end of the field, 100 feet of sand has been drilled with only minor shale beds near the top of the sand. Although the upper part of the sand shows oil in some of the wells, the main pay level, as a rule, lies 50 feet below the top of the sand. No water has been found in the base of the sand in wells high on the anticline.

Richter sand.—Production below the Tonkawa sand was found in only one well, theAmerada Petroleum Corporation No. 3 Richter, SE. cor. NE. ¼ Sec. 35, T. 25 N., R. 1 W., good for 30 barrels from the sand at 2,811 tc 2,830 feet, and later drilled into water. In all, eight wells have been drilled to this depth but no oil was found

[1] J. S. Ross, "Preliminary Report on Tonkawa Field," *U. S. Bur. Mines* (February, 1923), published by the Bartlesville Chamber of Commerce, Bartlesville, Oklahoma.

in the sand. The sand thickness in the Amerada well was 50 feet. It is probable that this sand will be productive higher on the structure.

Layton sand.[1]—A sand found 630 feet below the top of the Tonkawa sand has been found in eight wells which have been drilled outside of the producing area. This sand has been correlated with the Layton sand of the Cushing field. Several shows of oil have been found in the sand and it is thought that it will be productive in the main part of the field.

Deeper sands.—Another water sand was found by the Ossenbeck well, from 3,555 to 3,590 feet. The Mississippi lime and Wilcox horizons have been estimated to lie at depths of 4,100 and 4,400 feet, respectively.

Sand correlations.—Sand in fields of northern Oklahoma have often been named by the depths of the sand in the discovery wells. This practice should be discouraged as it is very confusing, especially in fields where there are numerous sands, as at Tonkawa. The same sands are also known by different names in other fields. The following equivalents have been determined by F. P. Geyer, Fritz Aurin, and G. C. Clark, of the Marland Refining Company.[2] The 800-foot sand zone of Tonkawa is present in a number of fields and is highly important for its gas production. The Hotson sand of Garber is probably a part of this series. Gas production from this series is found in the following fields: Deer Creek, 1,300-foot; Billings, 950-foot; Ponca City, 500-foot; Blackwell, 750-foot.

The Newkirk sand, called at Tonkawa the "1,750-foot gas sand," is best known in the Newkirk or Mervine field. It has been correlated with the following producing sands: Blackwell, 1,400-foot gas; Ponca City, 1,300-foot oil; Deer Creek, 2,000-foot gas; Garber, 2,200-foot oil.

The Hoover sand zone, one of the prominent horizons of the area has been correlated with the Elgin sand of the eastern Osage. The Upper Hoover sand of Tonkawa, South Billings, and East

[1] On February 26, 1924, T. B. Slick *et al.* deepened their No. 1 A in the SW. corner, Sec. 35, T. 25 N., R. 1 W., to the Layton sand, the top of which was found at 3,050 feet. The main body of sand occurred from 3,079 to 3,120 and carried salt water. This is very discouraging for prospects of deeper production in the Tonkawa field.—EDITOR.

[2] Ira Rinehart, *Report on the Oil Situation in North Central Oklahoma*, 58 pp., published privately in Tulsa, Oklahoma, 1922.

Billings is found in the following fields: Ponca City, 1,500-foot oil; Blackwell, 1,500-foot oil; Newkirk, 1,250-foot oil; Tonkawa, 1,800- and 2,000-foot oil; South Billings, 2,050-foot oil; East Billings, 2,000-foot oil.

The sand at the base of the Hoover sand zone or Elgin sand is called the "Lower Hoover sand" at Tonkawa, East Billings, and South Billings, but is productive at several other fields: Blackwell, 1,750-foot oil; Ponca City, 1,650-foot oil; Deer Creek, 2,400-foot gas.

The Endicott sand of the Tonkawa field is the probable equivalent of the following sands: Blackwell, 1,950-foot oil; Ponca City, 1,800-foot oil; Newkirk, 1,500-foot oil; South Billings, 2,400-foot oil.

The Tonkawa sand, one of the most persistent as well as productive sands of northern Oklahoma, has been correlated as follows: Blackwell, 2,200-foot gas (Stalnaker sand); Ponca City, 2,100-foot oil (Stalnaker sand); Deer Creek, 2,900-foot oil (Swaggart sand); Newkirk, 1,800-foot oil; Billings, 2,700-foot oil; Morrison, 2,000-foot gas; Tonkawa, 2,400–2,650-foot oil (Tonkawa sand).

The top of the Mississippi Lime where the chert is porous and well located on structure is productive in this area. It produces in the following fields: Ponca City, 3,600-foot oil; Blackwell, 3,300-foot, oil. It is estimated that this horizon will be found at a depth of 4,100 feet at Tonkawa.

The Wilcox is present at Ponca City and Blackwell at depths of 3,900 feet and 3,400 feet, respectively, but the Pennsylvania section at Blackwell below the "Oswego" limestone is almost entirely missing because of the Ordovician buried hill.

STRUCTURE

SURFACE STRUCTURE

With the exception of a few shale and "mudstone" outcrops south and southeast of the field, there are no reliable beds on which dip readings can be made. This lack of outcrops resulted in the introduction of diamond core drills by several companies, to determine the size and nature of the fold. Test holes were drilled to depths of 150 to 200 feet, and reliable correlations on several beds were made from the cores obtained. Structure contour maps of the field, determined by these test holes, are not available, but

it is probable that they conform closely to maps based on correlations of logs of drilling and completed wells.

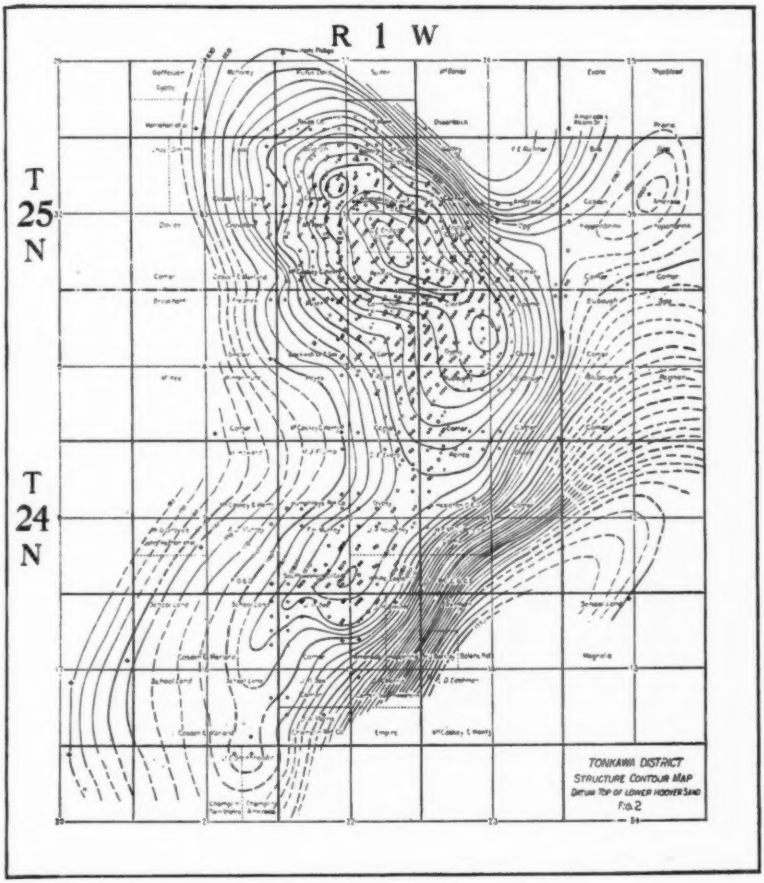


FIG. 2

SUBSURFACE STRUCTURE

Most of the fields in this section of Oklahoma are located on anticlines whose axes are more or less parallel to a general line of folding and mark the trend of the buried ridges which extend from

Kansas into Oklahoma. The axes of these folds trend due north to N. 30° E. The structure of the Tonkawa field (Fig. 1) differs in this respect as the direction of the axis of the major fold is northwest-southeast with only a long narrow nose extending to the southwest. The position of the anticlinal axis is shown on the structure contour map (Fig. 2). The fold is characterized by steep dips on the northeast and southeast flanks at the rate of approximately four hundred feet per mile. The dips on the western and southwestern flanks are more gentle. The fold is bounded on the east and north by deep regional synclines. The structure contour map (Fig. 2) is based upon the top of the Lower Hoover sand, which is a persistent sand and is the producing sand over a large area. It is very similar to the structure contour maps published by the United States Bureau of Mines.

PRODUCTION

QUALITY OF OIL

The oil produced at Tonkawa is light green in color and ranges in gravity from 42° to 44° B. The Upper and Lower Hoover sands carry oil which is slightly higher in gravity than that of the deeper sands. The oil contains a high percentage of gasoline and naphtha, and the casinghead gas is exceptionally good for casinghead gasoline plants.

WELL SPACING

The general practice of spacing wells in the Tonkawa field is to make first locations 250 or 300 feet from property lines with either four or five locations to the line of a quarter section. In the case of single 40-acre tracts, five locations are often made. Wells around the first location are 50 to 100 feet from it.

DRILLING SYSTEMS

The cable-tool system of drilling was used exclusively during the early development of the field, but due to the difficulty of drilling through the gas sands and red beds, the rotary system was substituted and has been so successful that at the present time nearly all wells are drilled by this method. Wells near the edge of the field are the exceptions. The Southwestern Oil and Gas Company,

No. 9 Murray, Sec. 10, T. 24 N., R. 1 W., was the first well drilled with rotary tools. Drilling on this well was started on March 15, 1922, almost a year after the completion of the discovery well. Although the drilling of this well required nearly 100 days, it offered a solution to the problem of mudding off the various sands. Since this well was completed a better understanding of conditions has made rotary drilling more efficient, and the average time to drill a well to the Tonkawa sand is about 50 days.

While the rotary has several advantages over cable tools in length of drilling time and ease in drilling and mudding sands, it has several distinct disadvantages. Rotary logs as a rule are very poor, due to the failure of drillers to note changes in formations. Except where explicit directions are given to watch for definite horizons, little attention is paid to the returns, and no samples are taken. The driller relies solely upon his ability to detect the various formations by the action of the drill stem and mud pump. As a result, the log shows very thick beds of gumbo and bowlders, shale with lime shells, and limestone. Water sands, unless they bear enough water to thin the mud appreciably, and oil sands are passed through without notice by the driller. Core samples of sands are taken, using the single core barrel with ordinary saw teeth. The core obtained is usually only 6 to 8 inches in length, and no attempt has been made to use the double core barrel to obtain longer and more desirable cores. As the first well on a location is usually drilled to the Tonkawa sand, cores of the upper sands will yield desirable information to guide later tests to those sands. The ordinary fishtail bit is used to drill through shales and soft limestones, but the use of the rock bit of the revolving cone type is frequently necessary due to the number of hard limestones.

When the rotary system is used, the hole is drilled to within 15 or 20 feet of the top of the sand. At this point, a string of $8\frac{1}{4}$-inch casing (usually 32-pound casing) is cemented. When cementing above the Lower Hoover sand, 250 to 350 sacks of cement are used, while from 400 to 600 sacks are used in wells to the Tonkawa sand. This amount is thought to be sufficient to fill the annular space between the casing and the wall of the hole so that the sands are effectively sealed and migration from one sand to another is pre-

vented. The cement is allowed to set from ten days to two weeks. A minimum of ten days is required by the Corporation Commission. While the cement is setting, the rotary rig is moved off the location and the rig is standardized for drilling in. In some cases, the rotary rig is skidded to another location and a steel rig is erected in its place. On one lease, four wells have been drilled with the same wooden rotary derrick.

In order to push development, separate derricks are erected for each of the sands and it is not uncommon to see 3 or 4 wells on one location. The Gypsy Oil Company has 6 wells in one group in the northwest corner of Sec. 2, T. 24 N., R. 1 W., Clark lease. Of this number 2 are gas wells and 4 are oil wells. To date, November 1, 1923, there are 80 locations on this quarter section. The Amerada Petroleum Corporation has 31 locations on its 80-acre Goltry Lease, W. ½ NE. ¼ Sec. 34, T. 25 N., R. 1. W.

CASING PROBLEMS

Where there are five oil sands with several water sands, as is the case at Tonkawa, the protection of oil and gas sands becomes of great importance. Special care is therefore necessary in effectively sealing these sands by proper casing methods to prevent the migration of fluids from one sand to another. In rotary holes, 40 to 75 feet of 15½- or 12½-inch casing is cemented to shut off surface waters. No other casing is used then until the final string of 84-inch is cemented above the sand. The Halliburton process is used in cementing all wells in the field. When the well is drilled in with cable tools, a liner is set on top of the sand.

When cable tools are used, 20-inch casing is set at or near 75 feet to shut off surface waters. The 15½- or 12½-inch casing is set below the gas and water sands found at 800 feet. The 10-inch casing is carried below the Newkirk sand and above the Upper Hoover at about 1,700 or 1,800 feet. When the Upper Hoover is not productive, the 8¼ is set below the Middle Hoover, which usually carries water, and the 6⅝-inch casing is set on top of the sand. In event that the Lower Hoover is productive and the well is being drilled to the Tonkawa sand, a string is landed between the Lower Hoover and the Carmichael to protect the Lower Hoover.

The final string is landed just above the Tonkawa sand. The Bureau of Mines has recommended that the final string be cemented, and this tested for 12 hours before the well is drilled in. When oil, gas, and water sands are cased off behind a single water string, the use of a column of mud behind the casing and above the cement plug will effectively seal the sands provided the mud is of the right consistency and the column is maintained to the surface.

PIPE LINES

Lease lines.—Flow lines and gravity lines consisting of 3- or 4-inch pipe are usually complete before the top of the sand is reached. As most of the oil is pipe-line oil and contains no basic sediment, it is run from the flow tank or separator direct to stock tanks for delivery to the pipe lines or into steel storage.

Major pipe lines.—The rapid development of the field required a large number of pipe lines to take care of all the production. At the present time there are seventeen pipe lines running crude from Tonkawa, few of which are running at their estimated capacity.

Table I shows the lines with the estimated capacity of each line and a comparative table showing actual runs.

TABLE I

PIPE-LINE FACILITIES IN THE TONKAWA FIELD

Company	Size of Line (Inches Diameter)	Estimated Capacity Barrels	Daily Average in April, 1923
Champlin Refg. Co.	8	17,500	5,878
Globe Refg. Co.	2	2,500	2,292
Moore Refg. Co.	6	10,000	3,820
Dohnelly Oil Works	3	1,500	....
Bolene Refg. Co.	2–4	8,000	4,674
Prod. Refg. Corp.	3, 4	4,500	1,649
Sinclair Pipe Line Co.	8, 2–4	20,000	3,328
Gulf Pipe Line Co.	6	12,000	11,539
Ozark Pipe Line Co.	looped 6	20,000	18,825
Cosden Pipe Line Co.	2–4	8,000	6,707
Oklahoma Pipe Line Co.	4	4,000	784
Empire Pipe Line Co.	4	6,000	6,335
Kay County Gas Co.	4, 6, 8, 10	50,000	27,835
Prairie Pipe Line Co.	6	10,000	3,835
Lubrite Refg. Co.	4	2,000	....
Texas Co.	8	10,000	....
Golden Rule Refg. Co.	4	2,000	424
		188,000	97,315

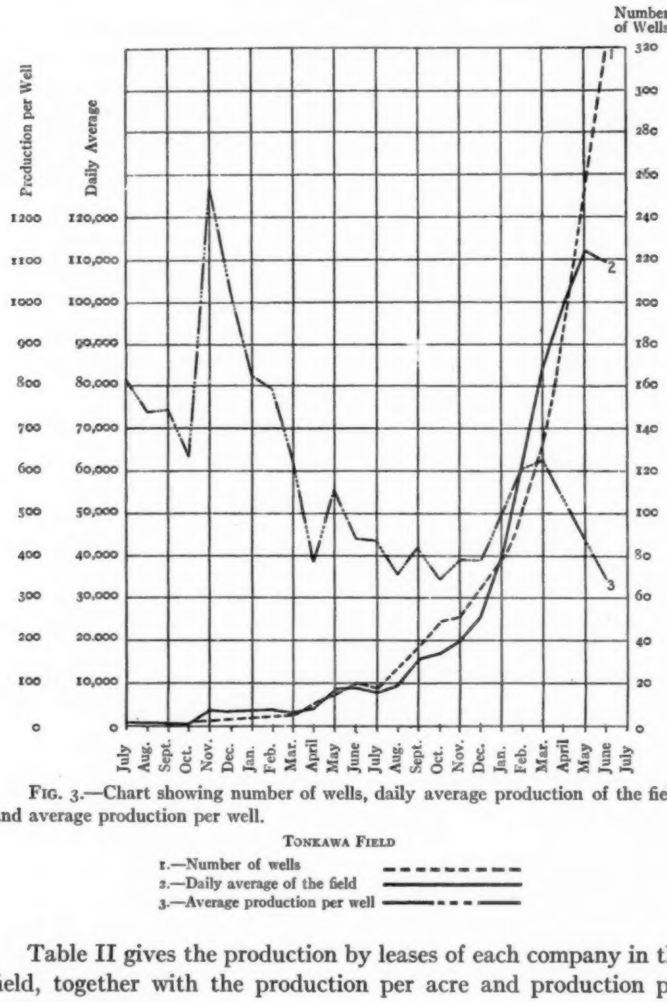


FIG. 3.—Chart showing number of wells, daily average production of the field, and average production per well.

TONKAWA FIELD

1.—Number of wells
2.—Daily average of the field
3.—Average production per well

Table II gives the production by leases of each company in the field, together with the production per acre and production per well of each lease.

T. B. Slick and Comar Oil Company deepened their No. 1A Endicott, located in the southwest corner of Sec. 31, T. 25 N., R. 1 W., and on April 9 found the Wilcox sand at 4,047 feet. The

TABLE II

TOTAL PRODUCTION OF THE TONKAWA FIELD, KAY AND NOBLE COUNTIES, OKLAHOMA, FROM ITS OPENING ON JUNE 29, 1921, TO APRIL 2, 1924

Location	Farm	Company and Month Production Began	Acres	No. Wells	Total Production	Prod. per Acre	Av. Prod. per Well
S.½, SE.¼	27-25-1W	Suiter, McMan Oil Co., May, 1923	80	3	64,433	805.4	21.478
SW.¼	27-25-1W	Davis, The Texas Co., July, 1923	160	5	54,691	341.8	10.938
SE.¼	28-25-1W	Mahoney, McCaskey & Wentz, October, 1923	160	1	1,015	6.3	1.015
NE.¼	33-25-1W	School land, Marland Refining Co. and Cosden Oil & Gas Co., January, 1923	160	10	245,628	1,535.2	24.563
NW.¼	34-25-1W	Beverlin, Comar Oil Co., December, 1922	160	49	1,596,150	9,975.9	32.574
N.½, SE.¼	34-25-1W	E. Endicott, Comar Oil Co., January, 1923	80	29	1,979,195	24,739.9	68.248
S.½, SE.¼	34-25-1W	C. Endicott, Pennok Oil Co., November, 1922	80	26	1,796,038	22,450.5	69.078
W.½, NE.¼	34-25-1W	Coltry, Amerada Petroleum Co., January, 1923	80	29	1,817,760	22,722	62.681
NE.¼, NE.¼	34-25-1W	McDaniels, Phillips Petroleum Co., March, 1923	40	4	228,519	5,713	57.130
SE.¼, NE.¼	34-25-1W	McDaniels, Blackwell Oil & Gas Co., February, 1923	40	14	494,799	12,370	35.343
SW.¼	34-25-1W	McKee, McCaskey & Wentz, September, 1922	160	42	2,577,403	16,108.7	61.367
SE.¼	35-25-1W	Ogg, Comar Oil Co., January, 1923	160	12	595,327	3,720.8	49.611
N.½, SW.¼	35-25-1W	L. Endicott, Comar Oil Co., January, 1923	80	23	933,492	11,688.7	40.587
NW.¼	35-25-1W	Goltry, Carter Oil Co., April, 1923	160	6	317,735	1,985.9	52.956
S.½, SW.¼	35-25-1W	L. Endicott, T. B. Slick and Comar Oil Co., December, 1922	80	31	2,647,337	33,091.7	85.398
SW.¼	36-25-1W	Koffenbrink, Comar Oil Co., April, 1923	160	1	2,334	14.6	2.334
NE.¼	36-25-1W	Sipe, Amerada Petroleum Corp., October, 1923	160	1	2,884	18.0	2.884
NE.¼	2-24-1W	Gaume, Comar Oil Co., January, 1923	160	26	811,526	5,072.0	31.213
SW.¼	2-24-1W	Blubaugh, Comar Oil Co., November, 1922	160	53	1,698,568	10,616.1	32.048
SE.¼	2-24-1W	Blubaugh "C," Comar Oil Co., May, 1923	160	8	477,358	2,983.5	59.670
NW.¼	2-24-1W	Clark, Gypsy Oil Co., September, 1922	160	69	3,451,838	21,574	50.027
NE.¼	3-24-1W	Carmichael, Comar Oil Co., June, 1922	160	60	2,567,198	16,045	42.787
SE.¼	3-24-1W	Ruzek, Comar Oil Co., September, 1922	160	31	902,846	5,642.2	29.124
NW.¼	3-24-1W	Ruzek, Blackwell Oil & Gas Co., September, 1922	160	17	1,345,068	8,406.7	79.122
SW.¼	3-24-1W	Hayes, McCaskey & Wentz, October, 1922	160	1	11,222	70.1	11.222
NE.¼	4-24-1W	Frederick, Sinclair Oil & Gas Co., August, 1923	160	1	3,150	19.7	3.150
NW.¼	10-24-1W	Plumb, Humphreys Petroleum Co., August, 1922	160	2	43,219	270.1	21.610
SW.¼	10-24-1W	Murray, Southwestern Petroleum Co., November, 1921	160	15	1,631,418	10,196.4	108.761
NE.¼	10-24-1W	Evans, Gypsy Oil Co., September, 1922	160	21	1,180,458	7,377.9	56.212
N.½, SE.¼	10-24-1W	Novotny, Prairie Oil & Gas Co., June, 1922	80	13	598,520	7,481.5	46.040
S.½, SE.¼	10-24-1W	Novotny, White Eagle Oil & Refining Co., March, 1922	80	7	513,632	6,420.4	73.376
NE.¼	11-24-1W	Oliver, Comar Oil Co., June, 1922	160	2	36,687	229.3	18.344
NW.¼	11-24-1W	Rence, Healdton Oil & Gas Co., December, 1922	160	24	1,357,286	8,483	56.553
W.½, NE.¼	15-24-1W	Smith, Amerada Petroleum Co., February, 1922	80	5	238,371	2,979.6	47.674
NW.¼	15-24-1W	See, Comar Oil Co., November, 1921	160	12	1,664,954	10,406	138.746
S.½, SW.¼	15-24-1W	Morris, Champlin Oil & Refining Co., June, 1922	80	1	37,085	463.6	37.085
E.½	16-24-1W	School land, Cosden Oil & Gas Co. and Marland Refining Co., July, 1921	320	6	402,959	1,259.3	67.160
E.½, NE.¼	21-24-1W	Smithhisler, Champlin Oil & Refining Co. and Amerada Petroleum Corp., January, 1923	80	1	19,493	243.7	19.492
W.½, NE.¼	21-24-1W	Smithhisler, Champlin Oil & Refining Co. and Twin State Oil Co., July, 1923	80	1	5,131	64.1	5.131
SW.¼	21-24-1W	Burch, Champlin Oil & Refining Co., November, 1923	160	1	189	1.2	189
		Total	5,360	663	34,352,916	6,409.1	51.814

well has been drilled to 4,085 feet, and on April 15 was producing 2,900 barrels of 44° Bé. gravity oil. The section to the Bartlesville sand horizon was normal, but the entire Mississippian section was missing and the Wilcox sand directly underlies the Pennsylvanian. The sand grains in the Wilcox are indistinguishable from the sand grains in the Wilcox sand in the Stroud pool. The absence of about 300 feet of section indicates the presence of a pronounced buried hill similar to the one in the Billings field found by the Mid-Co. Petroleum Company, Washburne No. 11A in Sec. 15, T. 23 N., R. 2 W. No production was found between the Tonkawa sand and the Wilcox although there was a show of oil in the Oswego lime and at approximately the Bartlesville horizon.

CONCLUSION

Due to the present marketing conditions, there is very little drilling in the Tonkawa field, and the daily average production steadily decreases (Fig. 3). Operators, however, are very optimistic and firmly believe that in the near future development will be carried to the deeper sands, which will prove productive, and the daily average production will be brought back to the former peak of 115,000 barrels per day.

KEROGEN AND ITS RELATION TO THE ORIGIN OF OIL[1]

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Kerogen is a term which was first proposed by Crum Brown and later defined by Cunningham Craig[2] as, "neither petroleum, bitumen, nor resin, but yielding petroleum and ammonium compounds on distillation." Although something has been learned about the physical properties of kerogen since the publication of this article, very little has been learned about its chemical composition. There are several reasons for this, chief among which is the fact that it is rather difficult to isolate enough kerogen for study, and also kerogen and oil shales have been of little value, comparatively, in the commercial life of our nation during the past few years. However, a number of research chemists are today working on this subject, and it is hoped that in the near future more will be learned about the chemical structure and behavior of kerogen.

In this paper the author wishes to outline a series of studies, which were based on destructive distillation, compression, and microscopic study of shales containing kerogen, and the suggestion which this study has offered as to the origin of oil.

[1] This paper was presented before the Association at the Tulsa meeting in 1921. It was the intention of the author to prepare additional photographs illustrating what appears to be a dissemination of organic detritus subsequent to deposition and also a number of photographs showing heating effects. Before this work was completed the author left for Mexico, where he is now living. Conditions in Panuco for laboratory work are so unfavorable in many ways that it has been decided to publish the article in its present form, and at some future date to publish a more complete analysis of some of the suggestions which are here set forth.

This study was begun for the Empire Gas & Fuel Company, and credit is due this company for the opportunity of collecting material and making numerous distillations. The author also gratefully acknowledges the diligent efforts of his wife and Mr. Davis, who prepared a great number of thin sections for the microscopic study. Credit is also due Messrs. David White and K. C. Heald for helpful criticism of the manuscript.

[2] E. H. Cunningham Craig, "Kerogen and Kerogen Shales," *Jour. Inst. Pet. Tech.*, June, 1916.

OIL SHALE DEPOSITS IN THE UNITED STATES

The most important occurrence of oil in this country is in the Green River basin in Colorado, Utah, and Wyoming. The following is a brief description of these beds in the vicinity of De Beque, Colorado. The deposit is the middle member of the Green River formation which is Eocene in age. The beds lie practically horizontal about 1,000–1,500 feet above the valley floor. The Green River formation is thought to be of fresh-water origin, because of the plant, fish, and insect remains which it contains.

The shale cliff has three major divisions. The upper 100–150 feet is composed of thin-bedded, light-colored shales, which weather to form slightly rounded slopes of about 25°–35°. Near the base of this division are two beds of rich, chocolate-brown shale, each from 2 to 8 feet thick. These beds are the massive or curly type of shale.

Below this group is 200–250 feet of practically barren shale, which weathers to form a precipitous, in many places almost vertical, cliff. These shales are characteristically very light gray in color with occasional delicate yellowish or purplish hues.

The lower group is about 50 to 60 feet thick, and is composed of many thin beds, mostly dark brown in color, which will yield about 25 to 30 gallons of oil per ton. Near the top of this group is a massive bed of rich, curly shale 2–6 feet thick, and near the base are two beds of rich paper shale, each about 4 to 10 feet thick. These "rich" beds yield from 60 to 80 gallons of oil per ton of shale, a very few yielding still larger amounts.

THE OCCURRENCE OF KEROGEN

Kerogen is found in practically all of the black shales which occur near the producing sands in most oil fields, in nearly all types of coal, and, abundantly, in oil shales, torbanite, gilsonite, etc. The presence of kerogen in the parent-rock, as seen in thin section, may be indicated merely by a slight coloration disseminated throughout the entire mass, or, as yellow to orange or brownish-colored, irregularly-shaped fragments, of resinous or semi-vitreous appearing material, promiscuously scattered or arranged along the bedding planes. An examination of more than 500 thin sections of oil

shales and coal has revealed no piece of kerogen larger than $\frac{1}{2}$ inch in diameter. The particles seem to be intimately associated with the components of the shale, although somewhat less intimately associated in the case of coal. An attempt was made to separate mechanically a quantity of kerogen by pulverizing an oil shale, rich in kerogen, to 200 mesh and then "floating off" the kerogen in various flotation fluids, but with no success. In one case Thoulet's solution was used in dilutions with a specific gravity range from 2.8 to 1.1, and at every step it was difficult to recognize any appreciable difference in the amount of kerogen contained in the portion which floated from that which settled.

PHYSICAL PROPERTIES OF KEROGEN

Kerogen is insoluble in organic solvents, even when pulverized to an impalpable powder. In one experiment an oil shale rich in kerogen was pulverized to a very fine mesh, and a portion was placed in each of the following solvents: gasoline, alcohol, ether, carbon tetrachloride, and carbon bisulphide, and was allowed to stand for several months, with occasional agitation. These experiments were conducted at atmospheric pressure. Several samples of pulverized shale, some immersed in alcohol, others in carbon tetrachloride, were heated in open test tubes to the boiling-point of the solvents, but no coloration took place. The only evidence of solution was a slight coloration of the carbon bisulphide.

When heated, kerogen emits a thick, greasy liquid, which is yellow or brown in color, and readily soluble in organic solvents. This substance on further heating is vaporized, and these vapors, when condensed, yield shale oil, a product closely resembling petroleum, and also ammonium compounds. This distillation produces a residue of carbon. Examination of a great number of shales has suggested that the amount of oil which can be obtained from an oil shale is directly proportional to the quantity of kerogen present. Generally, in the case of the Green River shales, those which yield the greatest quantity of oil by distillation contain the greatest quantity of carbon in the residue, and also produce the greatest quantity of ammonium compounds. This latter feature is in direct contrast to the Scottish shales.

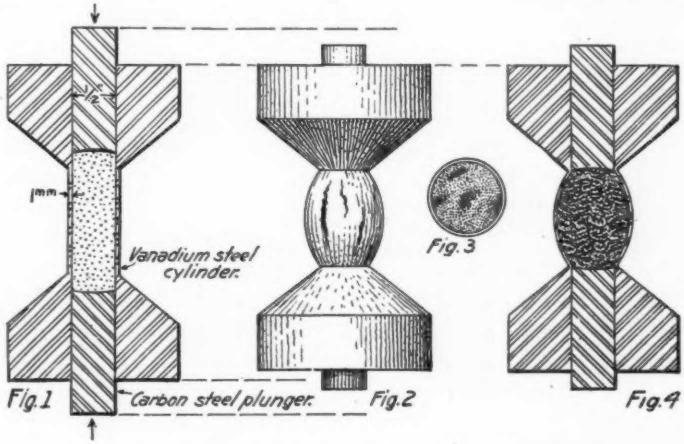
The production of carbon by natural distillation of kerogen may account for at least part of the carbon which is associated with many black shale beds. All of the black shale beds of the mid-continent area, which have been examined by the writer, contain kerogen. Many of these shales will yield from 8 to 10 gallons of oil per ton by destructive distillation. This is true of some shales which occur near the base of the Pennsylvanian about 3,000 feet below the surface, which were obtained from well cuttings. Because of the occurrence of kerogen in the shales which are found near the various oil sands, and because of the lack of evidence of any igneous activity near the shales in the oil regions, the question arose, "Will pressure convert kerogen into oil?" A series of experiments was conducted by A. W. McCoy and the writer to determine this point. A manuscript describing these experiments which has never been published was referred to in one of McCoy's recent papers.[1] Because of its direct relation to this discussion, a brief summary of the results of these experiments will be included here.

Cylinders of oil shale, $\frac{1}{2}$ inch in diameter by $1\frac{1}{2}$ inches long, were placed inside a steel cylinder, which somewhat resembled a spool in construction (Figs. 1 and 2). Pressure great enough to bulge the walls of the cylinders was applied by means of plungers. The cylinder was then sawed open and the shale examined. Figures 3 and 4 represent cross-sections after compression. A few moist spots could be detected with the aid of a lens, and, when fragments of the crushed shale were placed in organic solvents, a decided coloration was produced immediately. During this experiment no appreciable amount of heat was detected. This was evidenced by the fact that rather large lumps of soft tallow were placed all around the thin wall of the cylinder before the pressure was applied. The thin portion of the wall of the cylinder was only 1 mm. thick and this was not warmed sufficiently during the application of the pressure to cause any of the pieces of tallow to move.

A thin section of the material taken from the cylinder after compression showed a decided change in character. The shale before compression contained many gray spots which were not

[1] Alex. W. McCoy, "Notes on the Principles of Oil Accumulation," *Jour. Geol.*, Vol. XXVII, No. 4, May-June, 1919.

stained with kerogen, and a few fragments of kerogen; while the sample after compression was completely stained dark brown, and contained numerous aggregations of kerogen. This staining was probably due to liquid hydrocarbons produced during the compression. The material very closely resembled shale that had been heated, with the exception, of course, that no partings developed. On the contrary, the material was badly crumpled and slickensided. Distillation, producing liquid hydrocarbons, may have taken place by the frictional heat of molecular displacement. The question arises, "Will a lesser pressure applied over a long period of time



FIGS. 1–4.—Diagrams of steel cylinder used to compress oil shales

likewise convert kerogen into oil?" Microscopic study of oil shales has suggested that this may take place.

The last research on oil shales done by the writer, the results of which are still incomplete for publication, was a study of the relationship between organic detritus and kerogen. It seems probable that in most oil shales both of these materials are present. Kerogen might be described as a less adulterated product than organic detritus, or as an intermediate product between organic detritus and oil. Most kerogen is secondary to deposition, although some occurrences are primary. "Secondary" is not here meant

in the sense that the organic material was introduced subsequent to deposition, for the organic detritus was undoubtedly indigenous to the oil-shale beds, but by biochemical changes during compression, and probably further chemical changes after compression, there has been produced a different molecular structure from that of the original material. In other words, much kerogen has been derived from organic detritus. The writer believes it can be shown that most of the kerogen present in oil shales is derived from organic detritus and that much of it was formed after the parent shales were deposited.

TYPES OF OIL SHALES OBSERVED IN THIN SECTION

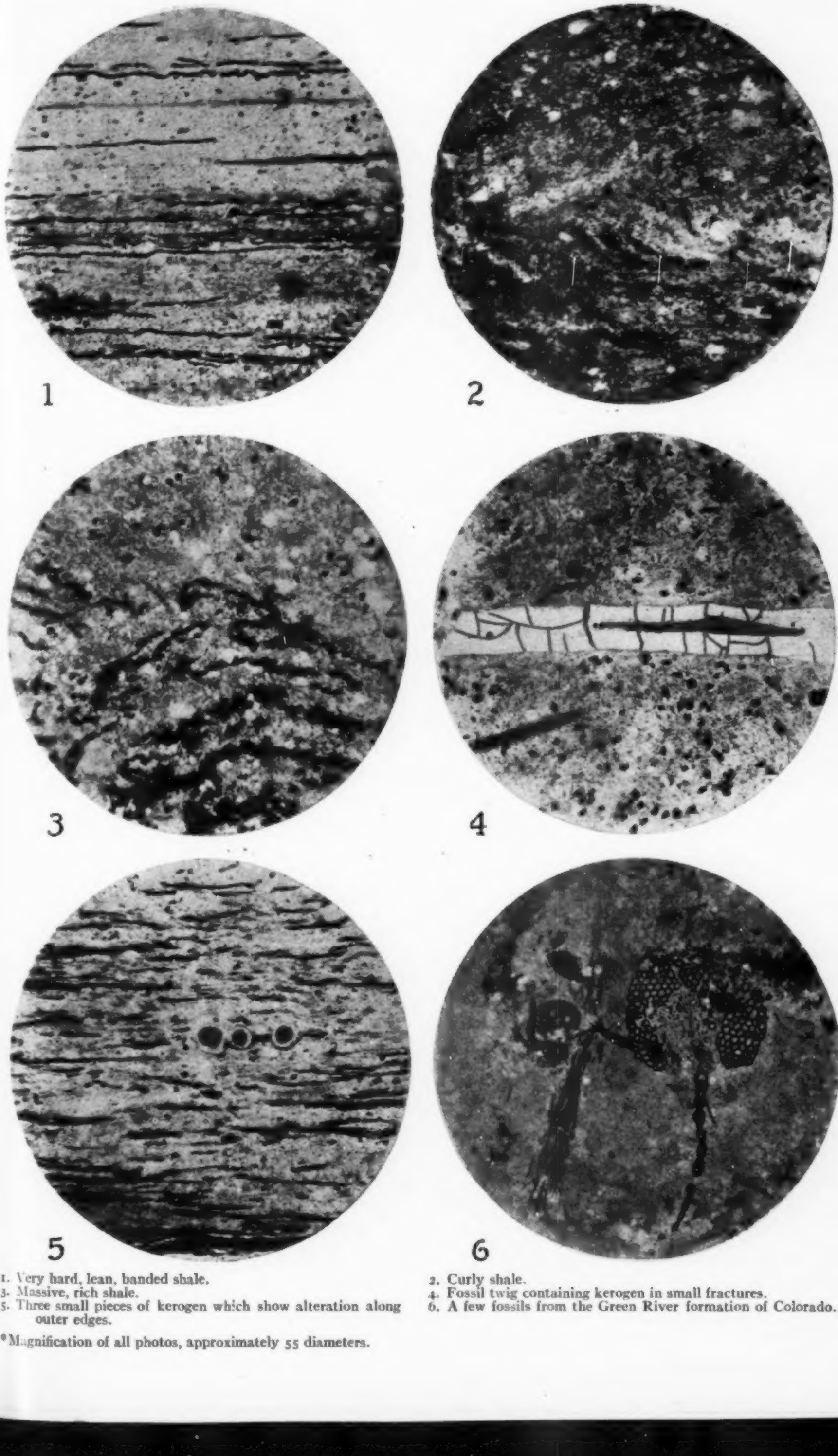
Under the microscope the structure of each type of oil shale has a characteristic appearance. Microphotographs numbered 1, 2, 7, 8, and 9 illustrate these various structures.

Thin-bedded lean shale.—Photograph 1 shows a typical hard, lean shale which has many laminae. This type of shale produces very little oil.

Massive lean shale.—Photograph 8 illustrates a lean shale of the massive type. Most of the material in this shale is colored a very light yellow, which indicates that only a small amount of kerogen is present. The black spots appear dark brown under the microscope, and are composed of organic matter. These shales are of little commercial value.

Massive rich shale.—Photograph 7 represents a massive shale which yields a large amount of oil by destructive distillation, and which shows irregular bedding planes in thin section which are not visible megascopically. These bands are dark brown in color and the material between the bands is a light brown. There is a large amount of kerogen scattered throughout the shale, but almost no large kerogen fragments are present.

Curly shale.—Photograph 2 represents a curly shale. It is composed of dark brown, irregular bands alternating with light brown to yellow bands, and contains a number of large, ragged-edged pieces of kerogen. This type of shale is second in value to paper shales for commercial oil production.

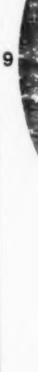


1. Very hard, lean, banded shale.
2. Curly shale.
3. Massive, rich shale.
4. Fossil twig containing kerogen in small fractures.
5. Three small pieces of kerogen which show alteration along outer edges.
6. A few fossils from the Green River formation of Colorado.

*Magnification of all photos, approximately 55 diameters.

B

7

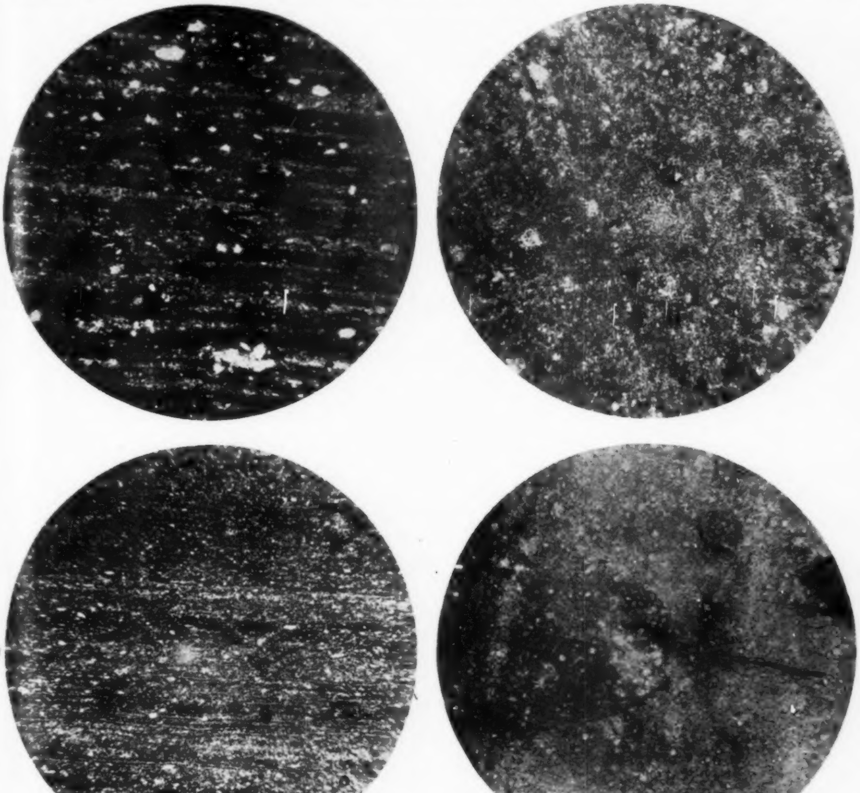


9

11

7.
9.
11.

*M



7 8 9 10 11 12

7. Massive, rich shale.
9. Paper shales. Section at right angle to bedding.
11. A rather large piece of kerogen can be seen near the center of this photo.

8. Massive, lean shale.
10. Fossil fragments in organic detritus.
12. An irregularly shaped piece of kerogen with a band of quartz reflecting its outline.

*Magnification of all photos, approximately 55 diameters.

Paper shales.—Photograph 9 shows the type of structure characteristic of paper shales. These shales when heated break down into very thin laminae and commonly yield considerable oil on distillation. As a type, the dark-colored paper shale which rings like hard rubber when pieces of it are struck together, or with a hammer, are first in commercial importance. They quite uniformly yield much shale oil, and are more easily mined than most of the other types.

Thin sections show that most of the material in the dark bands is organic matter, most of which has been decomposed beyond recognition. This material has been called sapropelic by several botanists; i.e., composed largely of algal remains, but there is little evidence to bear this out. Organic detritus is possibly a better term to apply generally to this material.

The writer examined a number of thin sections of foreign oil shales which were thought to contain a large percentage of algal remains, but it was found that in most cases when the material is greatly magnified the suggestion of algal structure disappears. A number of aggregates of kerogen were present which, when examined with a low-power lens, appeared to have granular or radial structure. However, when these aggregates were examined with an oil immersion lens, no trace of cell or wall structure was found.

Several objects which suggested chain algae were found, but unfortunately this work was not completed when the author left for Mexico, and inasmuch as these slides were not personal property, it was impossible to continue the work in Mexico. David White reports that he has found a number of shales which certainly contain algal remains, and that Thiessen has recently found similar evidence from the examination of sapropelic material which had been treated with an alkali. However, this does not mean that the organic detritus in all oil shales is composed predominately of algal remains.

In examining "rich" oil shales it is found that there are many bands or "patches" of organic detritus in these shales. In all cases this organic detritus is very dark brown in color. Occasionally, fragments of plant or animal structures are found in these

bands. Evidence of such organic structure is seen in photographs 6 and 10. A few bodies of kerogen are sometimes present in these bands as is shown in photographs 5, 11, and 12.

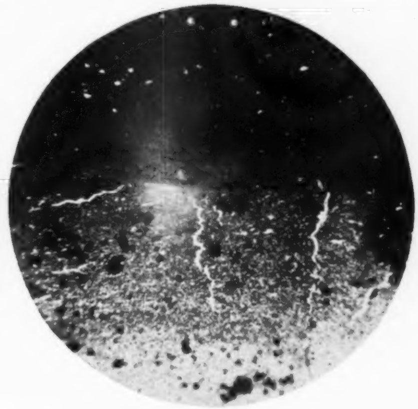
In a great many cases, especially those shales which yield a large quantity of oil, it is found that this organic detritus has a tendency to split up. In many instances the central portion of a mass of organic detritus is comparatively concentrated, while out toward the edges of the mass or aggregation the material is more scattered, and there are numerous suggestions of stringers leading away from the main body with many small pieces scattered around the edge. This material is opaque except in very thin section. In some cases the organic material is completely broken up into very small fragments with a greater concentration of organic remains near the center of origin. Photographs 17 and 18 illustrate two stages of this process. Part of the breaking up may have been effected during the period of consolidation of the shales, but very probably some alteration has taken place more recently.

It is unfortunate that the photographs cannot all be reproduced accurately in colors, for many of the refinements brought out by the microscope are lost in black and white prints. In practically all shales there is a marked graduation in color away from the layers or bits of organic detritus. The very dark brown near the center grades into an adjacent lighter brown zone, and this into yellow at a somewhat greater distance from the center. Most of the orange to yellow zones have optical characteristics typical of kerogen, but the line of separation between this and the central portion is difficult to determine.

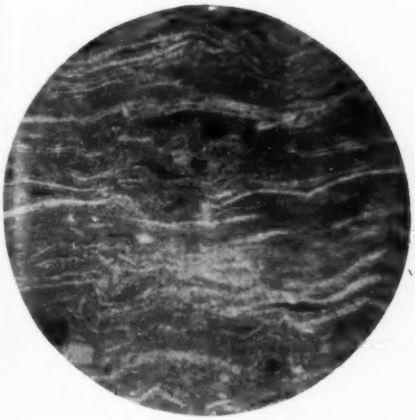
PHYSICAL PROPERTIES OF KEROGEN OBSERVED UNDER THE MICROSCOPE

Kerogen in its early stage is not optically active, and this property is of great value in determining its presence. Photograph 15 shows a shale containing considerable organic detritus, with much kerogen disseminated throughout the shale, which is recognizable by the yellow color which it imparts to the shale. Photograph 16 shows the same section under crossed nicols, the increase in dark areas indicating the position of the kerogen.

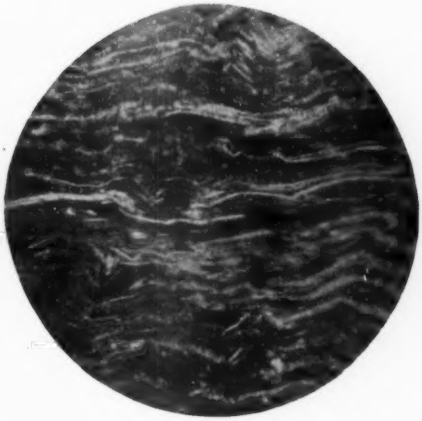
13



14



15



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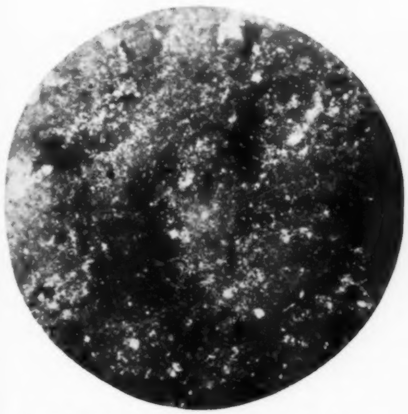

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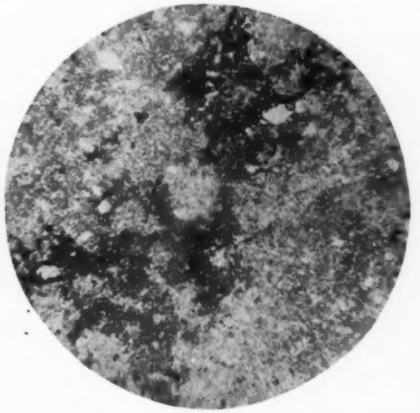

18

13. A heated shale, showing the large amount of kerogen which has collected into the partings produced by heating.
15. An oil shale which contains considerable kerogen disseminated throughout its entire mass.
17. Organic detritus, partially disseminated.

* Magnification of all photos, approximately 55 diameters.

14. A small piece of limestone containing fissures filled with kerogen.
16. Same section as 15 under crossed nicols. The increase in dark area quite accurately records the presence of isotropic kerogen.
18. Organic detritus, considerably disseminated

Microscopic evidence indicates that there are two types of kerogen in oil shales: one isotropic (optically inactive) in form, and the other anisotropic (optically active), the latter probably derived from the former. The inactive material occurs as yellow or orange bodies, or it may be present as a finely disseminated, gelatinous material which produces nothing more than a slight coloration of the shale. Some of the larger bodies of this material were undoubtedly present in a solid state at the time of the deposition of the shales. In photographs 11 and 12, two bodies of kerogen are seen to disturb the lamination. In slide 12 there is a band of quartz above the body of kerogen which roughly conforms to the outline of the kerogen. The shape of this body of kerogen suggests flowage or movement, which was probably caused by the pressure developed during the consolidation of the beds. Most of this type of kerogen has a granular appearance.

Evidence, suggestive that kerogen has been formed since the period of deposition, is seen in photographs 4 and 14. Number 14 shows a piece of fragmental limestone which was deposited with the shale, and which has a number of cracks, all of which are filled with the transparent type of kerogen. The cracks appear to have been developed since deposition. Photograph 4 contains what appears to be a fossil stem or twig, which has been replaced by quartz. Three stages of quartz are present, and at least two stages of kerogen are found in the cracks. Photograph 5 contains three bodies of kerogen which show evidence of alteration. The central portion of each body is composed of orange-colored, isotropic kerogen. The fringes are yellow in color, and are anisotropic at the extreme edges.

BEHAVIOR OF KEROGEN DURING DESTRUCTIVE DISTILLATION

In order to determine the effect of heating on oil shales, a number of duplicate slides were prepared, one of fresh shale, and the other of the same sample after it had been heated. It was found that a small amount of heating greatly increased the amount of kerogen. The first material which collected as a result of a small amount of heating was assumed to be kerogen because of its similar physical properties. If the heating was prolonged, all the kerogen was

driven off, and there remained a black shale containing a large amount of carbon.

By heating thin sections, which were prepared from fresh oil shale, it was found that a rapid concentration of kerogen follows a slight amount of heating, and at the same time there is a marked reduction in the organic detritus. The kerogen which is first formed is optically inactive. On further heating this isotropic kerogen becomes anisotropic and collects in cracks which develop along the laminae of the shale. Additional heating converts this material into a yellow or brown, greasy liquid, somewhat heavier than shale oil, which is readily soluble in organic solvents. Photograph 13 shows the appearance of a shale after it has been heated, all of the cracks, which appear as light bands, being filled with kerogen. The large, irregularly shaped body in the center is a mass of kerogen.

In the alteration from organic detritus to shale oil by destructive distillation a considerable quantity of inflammable gas is liberated. Many shales, which in thin section are seen to contain a considerable quantity of organic detritus, are disappointing in their small yield of oil, but they generally yield an unusually large amount of gas. Most gases obtained by the destructive distillation of oil shales, with the exception of those obtained at high temperature, are inflammable. In general, the higher the ratio of kerogen to organic detritus in a shale, the higher the ratio of oil yield to gas yield.

SUMMARY

A definition of kerogen which combines the views of both David White and the writer is as follows: The organic matter insoluble at low temperatures and pressures which yields petroleum by natural or artificial distillation.

Kerogen, although quite similar in appearance to resin is not a resin because of its insolubility at atmospheric temperatures and pressures in organic solvents such as alcohol, ether, and carbon tetrachloride, and because of the difference in its end products when distilled by the usual methods of destructive distillation.

Kerogen is most probably an intermediate product between an organic source; i.e., plants and animals and petroleum. The most

favorable conditions for the deposition and accumulation of such original organic derivative material is in swamps, bogs, lagoons, and within the zone of shore-line deposition.

Part of the kerogen which is found today was an end product of biochemical decomposition prior to consolidation and is indigenous to the beds which contain it. Other occurrences are secondary to deposition, probably derived from organic detritus.

Kerogen, when first formed, prior to being subjected to high temperatures or pressures, appears brownish to dark orange in color, and is optically inactive. Heating kerogen to a temperature slightly less than the temperature of vaporization and then allowing it to cool converts it into a vitreous, lemon-colored, anisotropic substance.

Kerogen can be converted into oil, either by the aid of heat, or by pressure. In the latter case, the pressure must be of such a nature as to allow molecular displacement.

AREAL GEOLOGY OF A PART OF SOUTHWESTERN OKLAHOMA[1]

ROGER W. SAWYER
Oklahoma City, Oklahoma

The basic work on the areal geology of the Permian redbeds of Oklahoma was done by Gould.[2] The present paper discusses the stratigraphy and general structure of a part of a large area north and west of the Arbuckle Mountains and surrounding the Wichita Mountains which was designated by Gould "redbeds of uncertain relation" (Fig. 1). C. W. Shannon, former director of the Oklahoma Geological Survey, aided materially with the expenses of the field work by providing E. A. Paschal as an assistant. Most of the time was spent in tracing the contact between the Duncan sandstone and the Marlow formation.

In 1915, Wegemann[3] traced an escarpment from a point near the village of Foster, T. 2 N., R. 3 W., westward to Duncan and thence northwest along the north flank of the Wichita Mountains to Fletcher (Fig. 2). It is possible to trace this escarpment farther in both directions than is indicated by Wegemann. It can be followed for a considerable distance northwest of Apache, marked by a heavy growth of blackjacks as far as Apache. This horizon perhaps can be correlated with the series of calcareous sandstones which passes in almost an east-west line just north of Komalty, Hobart, and Lone Wolf. East from Foster the escarpment describes a broad curve, passing east, then north and northwest, crossing Rush Creek in the vicinity of Wallville and extending in the direction of Lindsay. Though this horizon was not traced farther north, it is probably correlated with the sandstone formation east of Norman and Oklahoma City.

[1] Read before the Association at the Shreveport meeting, March, 1923. Manuscript received by the editor, March 13, 1924.

[2] C. N. Gould, *U. S. Geol. Survey, Water Supply Paper 148.*

[3] C. H. Wegemann, "Duncan Oil and Gas Field," *U. S. Geol. Survey Bull. 621.*

The sandstone which makes this escarpment, together with the thick series of overlying sandstone and conglomerate is here referred to as the Duncan sandstone. Its thickness is about 400 feet. The basal portion which forms the prominent escarpment differs from the upper portion in color in the region of the Duncan (Cruce) gas field. It is buff or yellow, while the upper portion is purplish, but this distinction is only local. The basal portion is in general

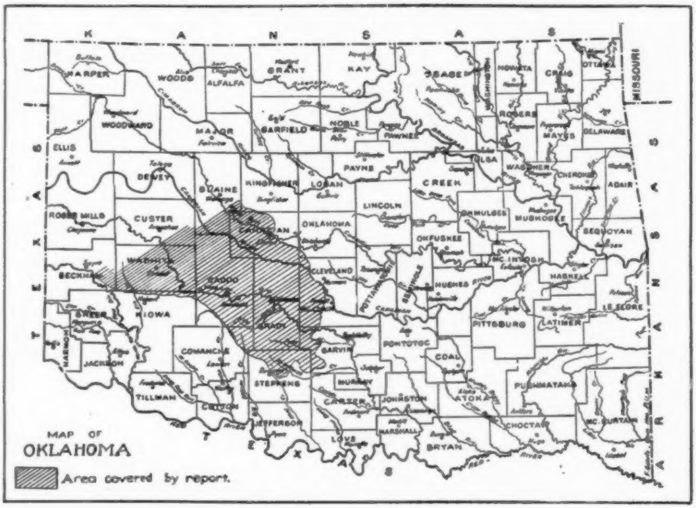

FIG. 1

composed of coarser material, but the gradation to finer materials continues to the top of the formation. The basal part of the Duncan apparently represents the rapid waste of an adjacent land, the detritus from which became gradually less coarse as the land was worn down. There seems to be no dividing line which can be traced over a large area, and the entire series is therefore a unit.

Above the Duncan sandstone is the Marlow formation which consists of brick-red shales and even-bedded brick-red sandstones with bands of fine white sand and sandy gypsums. The entire formation is gypsiferous, many of the shales containing veins of

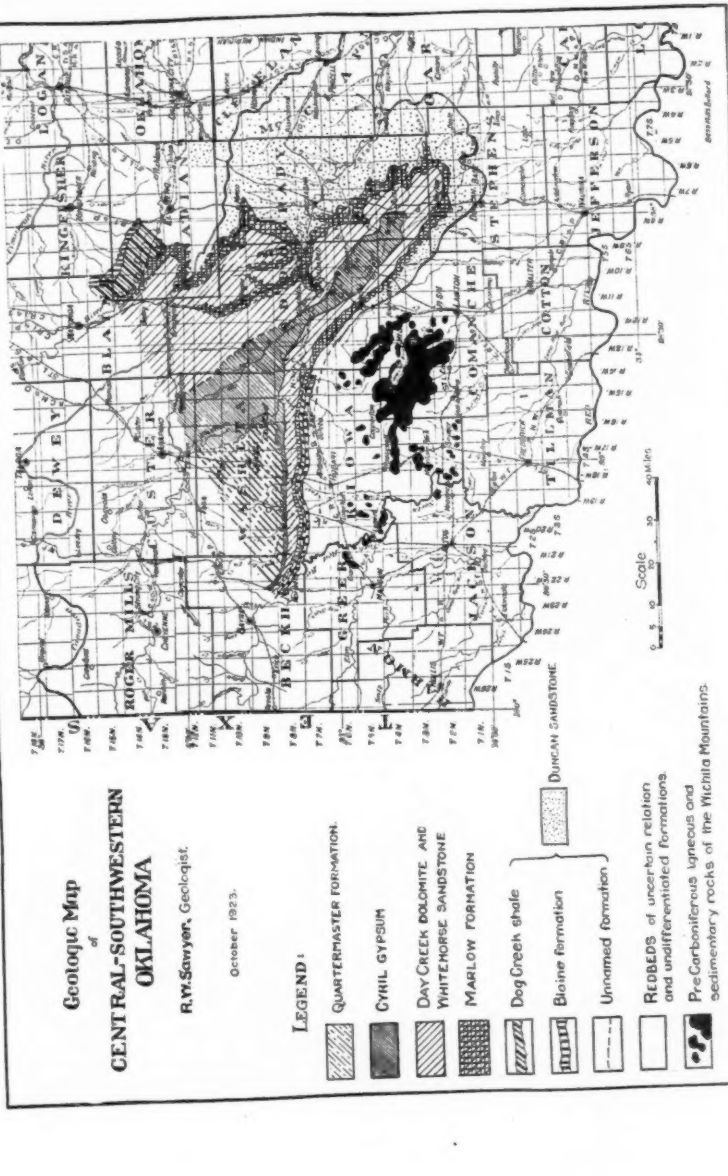
Geologic Map
of
CENTRAL-SOUTHWESTERN
OKLAHOMA
R.W. Sawyer, Geologist.
October 1923.
LEGEND:
QUARTERMASTER FORMATION.
CYRIL GYPSUM
DAY CREEK DOLOMITE AND
WHITEHORSE SANDSTONE
MARLOW FORMATION
Dog Creek shale
Blaine formation
Unnamed formation
DUNCAN SANDSTONE
REDBEDS of uncertain relation
and undifferentiated formations.
PreCarboniferous igneous and
sedimentary rocks of the Wichita Mountains
Scale
0 5 10 20 30 40 Miles
DEWEY
CUSTER
ROGER MILLS
BECKHAM
GREER
KIOWA
COMANCHE
TILLMAN
COTTON
JACKSON
JEFFERSON
STEPHENS
KINGFISHER
LOGAN

FIG. 2

satin-spar and the sandstones more or less gypsum. A thin layer of almost pure gypsum about 1 foot thick is found at the top of this formation. The thickness of the Marlow formation is about 120 feet.

The Whitehorse has been well described by Reeves[1] as a "friable, reddish brown, cross-bedded to regular-bedded sandstone which weathers rapidly producing a thick soil of sand that is blown about by the wind and in some localities piled up into sand dunes." In places it contains some shale, especially in the lower part of the formation in the Marlow area. It does not have the white bands common in the Marlow formation, but is of uniform color throughout, and it does not contain much gypsum.

Above the Whitehorse sandstone are the Day Creek dolomite, the Cyril gypsums, and the Quartermaster formation.

DUNCAN-MARLOW CONTACT

In Stephens County the contrast between the Duncan sandstone and the Marlow formation is very marked. The Duncan is predominately purple in color, while the Marlow is brick-red with regular white bands. The Duncan is predominately a sandstone and conglomerate while the Marlow in this area is largely shale. The Duncan is cross-bedded while sandstones which occur in the Marlow are, with two minor exceptions, even-bedded. There is also a noticeable difference in the vegetation along the outcrops, the Duncan being covered with large post oaks and blackjacks up to 18 inches in diameter, the Marlow lacking trees, except elms and cottonwoods along the creeks. The Whitehorse is locally covered with a growth of scrub blackjacks. Neither the Duncan nor the Whitehorse contain appreciable gypsum but the Marlow always contains enough to cause "gyp" water in all the shallow wells along its outcrop. The Marlow is eroded more slowly than the upper part of the Duncan and forms a bench along the contact. In the numerous small canyons this contact can be found exactly, and is one of the most accurately mappable horizons in western Oklahoma.

[1] Frank Reeves, "Geology of the Cement Oil Field," *U.S. Geol. Survey, Bull. 726B.*

Away from the Marlow district, certain important changes occur in the Duncan sandstone. In the first place, it becomes more shaley. In T. 4 N., R. 6 W., the increase in the amount of shale in the upper part of the Duncan becomes very noticeable; near Chickasha the formation is about one-half shale and near El Reno it is nearly all shale. The rapid increase in shale is reflected in the disappearance of oak trees, and northwest of T. 4 N., R. 6 W. the outcrop of the upper part of the Duncan resembles the treeless Marlow. Accompanying the change in material there is a change in color. Though the formation is never uniform in color at any one place the succession of colors from Marlow to El Reno is, in general, from very light purple with some green, to lilac, dark purple, dark red, and brick red. These changes in color are probably stages in the oxidation of the iron. In following the outcrop westward from Marlow to Carnegie, the same changes in material, color, and associated vegetation were observed as noted fromMarlow to El Reno. Northwest of El Reno the Duncan sandstone is divided by a series of gypsums and dolomites, which extends to the state line in Woods County. Gould called the series the Blaine formation. Similarly, in Secs. 13 and 14, T. 7 N., R. 14 W., southwest of Carnegie, one can see, within the Duncan sandstone, the commencement of a series of gypsums and dolomites which can be traced into the gypsums and dolomites which form the prominent river bluffs south of Carter. This series was designated by Gould as the western area of Greer gypsums.

It is noticeable that all these changes in the Duncan sandstone occur on both sides of the syncline at equal distances from the Marlow area. It should also be made clear that the changes in material and color which have been described apply to the upper part of the Duncan; similar changes occur in the lower part of the formation, but are not so rapid. Difficulty in finding the exact contact between the Duncan sandstone and the Marlow formation increases to the north and west, but it can still be found where erosion is rapid. It is easily seen in a small canyon on the east side of Sec. 30, T. 12 N., R. 8 W., and in a creek on the north line of Sec. 35, T. 8 N., R. 17 W.

CORRELATION

The following correlation with Gould's section is suggested:

<table>
<tr><th colspan="2">Gould's General Section for Western Oklahoma</th><th>Section West of Carnegie and El Reno (This Paper)</th><th>Section East of Carnegie and El Reno (This Paper)</th></tr>
<tr><td colspan="2">Quartermaster formation</td><td>Quartermaster formation</td><td></td></tr>
<tr><td colspan="2">Greer formation</td><td>Cyril gypsum</td><td>Cyril gypsum</td></tr>
<tr><td rowspan="4">Woodward formation</td><td>Day Creek dolomite</td><td>Day Creek dolomite</td><td>Day Creek dolomite</td></tr>
<tr><td rowspan="2">Whitehorse ss.</td><td>Whitehorse ss.*</td><td>Whitehorse ss.*</td></tr>
<tr><td>Marlow formation</td><td>Marlow formation</td></tr>
<tr><td>Dog Creek shales</td><td>Dog Creek shales</td><td rowspan="2">Duncan ss.</td></tr>
<tr><td colspan="2">Blaine formation</td><td>Blaine formation</td></tr>
<tr><td colspan="2">Enid formation</td><td>Enid formation</td><td>Undifferentiated shales and sandstones</td></tr>
</table>

*As defined by Reeves. *U. S. Geol. Survey Bull. 726B.*

The name Cyril was first applied to the gypsums of the Cyril and Cement area by Clapp[1] who correlated them with the Blaine. Reeves also used this name but correlated the gypsums with the Greer as Gould had done. It appears, however, that these gypsums are neither the Blaine, nor can they be connected with the gypsums along the bluffs of the north fork of Red River where Gould found his section of the Greer. They form a higher series as shown by the fact that the Duncan-Marlow contact, when traced north and west, passes *above* the Blaine and *above* the Greer (western area), but *below* the Cyril gypsum. The Blaine and the Greer (western area) seem to be the same formation, but on opposite sides of the large syncline. The writer's attention was called to this new correlation by Greene[2] and Beede,[3] both of these men having come to that conclusion prior to the field work for this paper.

[1] F. G. Clapp, "Geology of the Cement Oil Field," *Am. Inst. Min. and Met. Eng. Bull. 158*, Sec. 27, pp. 3-4, 1920.

[2] F. C. Greene, *Oil and Gas Journal*, p. 54 (May 7, 1920).

[3] J. W. Beede, *Texas Bureau of Economic Geology*. (In press.)

Comparison of these formations can best be obtained from Gould. For purposes of description he divides the Greer into two areas, the eastern area (Dewey, Custer Washita, Caddo, and Comanche counties) and the western area (Washita and old Greer counties). He says:

"In the western area of the Greer formation the rocks differ in several particulars from those in the eastern area. Instead of being unevenly stratified the rocks are deposited in regular layers. Sandstones are practically absent or at least inconspicuous, and the sequence consists of layers of gypsum and magnesian limestone or dolomite interstratified among the gypsiferous clays. . . . . These shales between the gypsum beds do not differ materially from those at the base of the formation nor from those between the gypsum ledges of the Blaine formation.[1]

Attention is thus directed to the lithological differences between the two areas of Greer, and to the similarity of the western area to the Blaine. Gould hesitated about correlating the two areas of Greer, but was led to do so because of the fact that the steep dip causes the two horizons to approach each other closely and the fact that the eastern Greer thins out and becomes less conspicuous in southwestern Washita county, just as the western Greer becomes more conspicuous, and also because of his lack of knowledge of the general structure of the area which is brought out clearly only by detail work. In this paper the upper gypsums which Gould referred to as the eastern area of Greer are designated by the name given by Clapp, the Cyril gypsums.

There is a very interesting bed in the Marlow, 80 feet from its base, which forms an escarpment from Verden to Ninnekah and thence to a point 10 miles east of Marlow in Sec. 13. T. 2 N., R. 6 W. It is a lenticular bed of coarse-grained, cross-bedded sandstone, not over 1,000 feet wide, which extends about 38 miles in practically a straight line. It is sometimes referred to as the "foot-print" sandstone because of some carvings of human and animal feet carved on some of the rocks of the formation at Rocky Bluff schoolhouse northeast of Rush Springs. The manner of formation of this bed is in doubt. Detail work shows that it follows the strike of the rocks closely and would seem to mark an old shore line of a body of water which existed during a part of the time

[1] C. N. Gould, *U. S. Geol. Survey Water Supply Paper 148*, pp. 64, 65.

in which the Marlow formation was deposited. Reeves referred to it as a fossil stream channel, which term was suggested earlier by Beede[1] and Waite[2] working independently in the region.

A sandstone of similar material and appearance is found in Sec. 22, T. 7 N., R. 8 W. It is less than a foot in thickness and is at the base of the Marlow. These two sandstones are the only examples of cross-bedding found within the Marlow formation.

Question is raised as to which of Gould's formations the Marlow formation corresponds. The Marlow was not traced to the type locality of the Whitehorse by the writer, but the following facts have a bearing on the correlation. (1) There are shales between the Marlow and the Blaine which correspond to the description of the Dog Creek shales as given by Cragin and Gould. These shales are similar in appearance to the shale members of the Blaine, but differ from the shales of the Marlow formation. (2) In many places it is difficult to draw an exact line between the Marlow and the Whitehorse. (3) In the area covered by this report, the "foot-print" and similar sandstones are limited to the Marlow formation. Beede has informed the writer that such sandstones are present in the Whitehorse sandstone at Whitehorse Springs. For these reasons the Marlow formation is thought to be a part of the White horse as it was originally named.

The Duncan sandstone grades into the Dog Creek shales, the entire Blaine formation, and a part of the Enid formation. The Duncan sandstone was taken as the base of the Whitehorse by Ohern.[3] It is believed that the confusion of these two formations was caused by the near approach of the Duncan sandstone to the Whitehorse at Fletcher. Unless the steep dip is known, a hasty reconnaissance might lead one to believe that the two formations are identical.

CONCLUSIONS

A large syncline with a steep south flank and a gentle north flank occurs just north of the Wichita Mountains, the axis of the syncline being parallel to that of the mountains. The Cement

[1] J. W. Beede, unpublished investigation for the Oklahoma Geological Survey.

[2] V. V. Waite, unpublished investigation for the Oklahoma Geological Survey.

[3] D. W. Ohern, *Bull. Amer. Assoc. Petroleum Geol.*, Vol. 3 (1919).

oil field and the Chickasha gas field are local anticlines almost in the center of this syncline.

The gradation of materials in the Duncan sandstone shows that the sediments came from the southeast. The coarseness of the conglomerates indicates that the source of the material was near at hand, and these facts point to the Arbuckle Mountains as the source of the Duncan. That the Wichita Mountains did not contribute to this formation is shown by the similarity of the Duncan sandstone on both sides of the large syncline. The source of material for the Marlow, Whitehorse, Cyril, and Quartermaster is not so clear. Within the area examined these formations did not disclose any consistent change such as has been noted in the Duncan sandstone. Reeves suggested that all the Permian redbeds were derived from the north and west, but it is worthy of note that he worked only on the Whitehorse sandstone and the Cyril gypsum. While his conclusions may be correct for these upper formations, they cannot be applied to the Duncan sandstone and the underlying formations.

DISCUSSION

W. C. Kite: From rather casual observations of the base of the Whitehorse in various parts of western Oklahoma, I am inclined to think that the Whitehorse is not conformable to the formations below it. I would like to ask Mr. Sawyer if he came to any such conclusions in his study of the formations.

R. W. Sawyer: Possibly there is such an unconformity. So much wind-blown sand is present that the exact contact is difficult to find, and consequently it is hard to determine the exact relation.

C. N. Gould: I am not familiar with conditions in the region discussed, but in the northern part of the state wherever I observed the Whitehorse, it appears to lie unconformably on the subjacent Dog Creek. I wish to congratulate Mr. Sawyer on a good piece of detailed work. When the formations were named in *U. S. Geological Survey, Water Supply Paper 148*, the greater part of the region described in Mr. Sawyer's paper was in the Chickasaw Nation, Indian Territory. My work being confined to Oklahoma Territory, I had no occasion to go over this part of the country. For a number of years I have been hoping that some of the younger men would work out the details in this region, and I am very glad that Mr. Sawyer has attacked the problem. I would like to ask Mr. Sawyer his estimate of the thickness of the Whitehorse.

R. W. Sawyer: It is difficult to find the top and base of the Whitehorse sandstone close together. Frank Reeves found such a place south of Anadarko and gives the thickness as 230 feet.

F. C. GREENE: This paper is one of the most notable contributions to Oklahoma stratigraphy and geologic mapping that has been made for some time. It is gratifying to the writer to know that his opinion expressed in the *Oil and Gas Journal*, May 7, 1920, page 54, that the Blaine and western Greer formations were the same and that the eastern Greer (now termed Cyril) would prove to be a higher formation, has been proved by field work.

It is my belief, however, that more field work is needed before all the tangles in the stratigraphy of this area are understood. There is some evidence that the Duncan sandstone is a composite formation and that it may even be partly of Permian and partly of Pennsylvanian age. In the southwestern part of T. 2 N., R. 3 W., there is a series of non-red shales and sandstones with a northwest dip overlain, in my opinion, unconformably by a dark-red to purplish-red sandstone or by red and white shales. The base of the red material exhibits a slope to the east. A little farther northeast both the red and gray sandstones appear in the escarpment in the Table Mountain region of western Garvin County and are nearly parallel, but soon begin to spread, the upper beds trending to the northwest and the lower beds to the northeast.

If this suggestion of unconformity is correct, it explains many things. Well logs have shown a great thickness of Enid below the Blaine in Washita County. This appears to be thin or absent in Garvin County, obviously going out by overlap.

The Blaine formation thins to the southeast. This may be a natural shoreward thinning or it may be due also to this overlap, but in either event it is contributory evidence to the presence of a land mass to the southeast. Some of the changes in the Duncan and Marlow formations that are noted by Sawyer may also be explained by the same overlap. It should be noted that these changes take place north and west of the type localities, as would be expected. I have not traced any of the sandstones in the Duncan formation west of the locality above mentioned and am at a disadvantage concerning them.

An overlap would also explain the divergence of opinion between Reeves and Sawyer regarding the origin of the sediments. Sawyer is probably correct concerning the origin of the material in the Duncan, at least the lower part, and Reeves in assuming the Whitehorse sediments to have originated in the northwest.

I question the propriety of establishing the name "Marlow" until it can be shown more definitely that it is not the Dog Creek shale. Reeves[1] mentions two places in which a 2-foot bed of gypsum is found lying 230 feet below the top of the Whitehorse sandstone. A slight thinning in the intervals given by Gould, a thinning to the southeast such as would be expected in the presence of an overlap, would place these gypsum beds in the Blaine. If this can be proved, it will help to clear up some of the problems in correlation.

[1] *Op. cit.*, pp. 67, 68.

A NEW CLASSIFICATION OF THE PERMIAN REDBEDS OF SOUTHWESTERN OKLAHOMA

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INTRODUCTION

The first papers dealing with the redbeds of Kansas and Oklahoma were published by F. W. Cragin in 1896[1] and 1897.[2] In 1902, the present writer published a brief description of the Oklahoma redbeds series,[3] in which the greater part of the names since used were employed, and in 1905[4] he published the classification which has since been in use. The geological map which accompanied this latter report set forth conditions as they were then understood. At that time the present counties of Grady, Stephens, Garvin, and McClain, in which are located a considerable part of the area discussed in the present article, were part of Indian Territory and were not considered.

During the past few years, subsequent work, largely by petroleum geologists, has shown that there are certain errors in both the classification and mapping used in this report. It therefore becomes necessary that the results of later investigations be made available; hence, this article.

Several papers on various local phases of the redbeds have appeared from time to time, especially those by Snider,[5] Wege-

[1] "The Cimarron Series of Kansas," *Colo. Coll. Studies*, Vol. 6 (1896), pp. 4 ff.

[2] "Observations on the Cimarron Series," *American Geologist*, Vol. 19 (1897), No. 5, pp. 351 ff.

[3] "General Geology of Oklahoma," *Second Biennial Report, Department of Geology and Natural History, Territory of Oklahoma* (1902), pp. 17–74.

[4] "Geology and Water Resources of Oklahoma," *U. S. Geol. Survey Water Supply Paper 148* (1905).

[5] L. C. Snider, "The Gypsum and Salt of Oklahoma," *Oklahoma Geol. Survey Bull. No. 11* (1913).

mann,[1] Aurin,[2] Ohern,[3] Greene,[4] Clapp,[5] Reeves,[6] and Howell,[7] but no attempt has been made to revise the classification of the series.

The particular part of the redbeds area of Oklahoma to which this article refers occupies all or parts of some ten counties lying east, northeast, north, northwest, and west of the Wichita Mountains. In January, 1924, a field conference was held in this region, under the direction of H. D. Miser, of the U. S. Geological Survey, who was then compiling information for a geologic map of Oklahoma. Members of this conference in addition to Mr. Miser were Dr. J. W. Beede, Dr. J. V. Howell, Messrs. C. Don Hughes, R. W. Sawyer, F. W. Floyd, and the writer. Studies were made of the various formations discussed in this paper, including the type sections of both the Blaine and the Greer formations. To each of the members of the conference is due the author's sincere thanks for co-operation, suggestions, and criticisms; also to Mr. Clyde Becker, who has submitted valuable information regarding the local stratigraphy of the "purple" phase of the Chickasha formation.

ANADARKO BASIN

In order to understand more clearly the areal geology of the region, it will perhaps be well to first mention briefly the major structure of this part of Oklahoma. The distinguishing structural feature of the entire area is a large synclinal basin, the axis of which extends southeast-northwest across the area discussed. The southeastern end or head of this basin, as it is now understood, is located

[1] Carrol H. Wegeman, "The Duncan Gas Field," *U. S. Geol. Survey Bull. 621D* (1915), p. 44.

[2] Fritz Aurin, "Geology of the Redbeds of Oklahoma," *Oklahoma Geol. Survey Bull. No. 30* (1917).

[3] D. W. Ohern, "A Contribution to the Stratigraphy of the Redbeds, *Bulletin American Association of Petroleum Geologists*, Vol. 2 (1918), pp. 114–17.

[4] Frank C. Greene, "Oklahoma's Stratigraphic Problem" (The Redbeds), *Oil and Gas Journal*, Vol. 18 (May 7, 1920), No. 49, p. 54.

[5] Frederick C. Clapp, "Geology of the Cement Oil Field," *Trans. Amer. Inst. Min. Met. Eng.*, Vol. 65 (1921), pp. 156–64.

[6] Frank Reeves, "Geology of the Cement Oil Field, Caddo County, Oklahoma," *U. S. Geol. Survey Bull. 726B* (1921).

[7] J. V. Howell, "Some Structural Factors in the Accumulation of Oil in Southwestern Oklahoma," *Econ. Geol.*, Vol. 17 (Jan.-Feb., 1922) No. 1, p. 23.

in northeastern Stephens County, a few miles northwest of the west end of the Arbuckle Mountains. From this point the axis of the basin is known to extend northwest for a distance of about 150 miles, until it appears to lose its identity, in the area occupied by the Quartermaster formation in northern Beckham and southern Roger Mills County. It is possible, however, that later investigations may show that this structural trough continues across the state line into the Panhandle of Texas, paralleling the buried granite ridge which is now believed to be the northwestern projection of the Arbuckle–Wichita Mountain axis.

Toward the axis of the Anadarko Basin, the rocks dip from both sides, the dips on the south side in the vicinity of the Wichita Mountains being steeper than on the north side. The same redbed formations are exposed in the same sequence on both sides of the basin. For this structural feature the name "Anadarko Basin" is proposed.[1] The name is from that of the county seat of Caddo County, which town lies well within the basin.

OLD CLASSIFICATION

In *U. S. Geol. Survey Water Supply Paper No. 148* referred to above, when the classification as then understood was set forth, the Oklahoma redbeds were divided as shown below:

Formations	Members
Quartermaster	
Greer	Mangum Collingsworth Cedartop Haystack Kaiser Chaney
Woodward	Day Creek Whitehorse Dog Creek
Blaine	Shimer Medicine Lodge Ferguson
Enid	

[1] Howell (*loc. cit.*) and others have used the name Washita syncline for this structural feature. It has been suggested, however, that the name Washita is overworked and, after considering the matter carefully, it seems wise to adopt some other name.

All of these formations are exposed in the area being discussed in this article.

NEW CLASSIFICATION

The changes in this classification, which have been worked out during recent years by various geologists whose opinions were crystallized by the January, 1924, field conference, may be briefly summarized as follows:

1. Two new formations, the Duncan and the Chickasha, occupying the same stratigraphic position as the upper part of the Enid, have been added.

2. A peculiar sandstone in the Dog Creek shale, which has the appearance of the prehistoric stream Channel, is recognized.

3. The name "Woodward" is abandoned. The consensus of opinion now is that the major subdivisions of the Permian should be based on unconformities at the base of the Quartermaster, Whitehorse, and Duncan (?), rather than on the presence of gypsums, as suggested in the old classification. One of these unconformities occurs near the middle of the Woodward formation, as that term was formerly used.

4. The name "Greer" is abandoned, it having been shown that the rocks formerly described as the "western area" of the Greer are in fact the stratigraphic equivalent of the Blaine, Dog Creek, Whitehorse, and Cloud Chief. For the so-called "eastern area" of the Greer, the term "Cloud Chief formation" is proposed.

The new classification, as now proposed, is as follows:

Quartermaster formation
Cloud Chief formation
Day Creek dolomite
Whitehorse sandstone
Dog Creek shale
Blaine gypsum
Chickasha formation
Duncan sandstone

A brief discussion of the various formations with which this paper is concerned, beginning with the oldest, is given herewith. No attempt is made at this time to indicate the detailed stratigraphy of the Enid formation, as that series of beds has heretofore been

known. A number of geologists, particularly Aurin and Clark, have done considerable work on this formation in the northern part of the state, and find that in that region the Enid may be divided into recognizable units; but these units have not yet been definitely mapped, nor have they been correlated with the beds (Duncan, Chickasha, etc.) in the vicinity of Anadarko Basin. Again, the line of separation between the Pennsylvanian and Permian in the region west of the Arbuckles has not been definitely determined at this time. There are those who believe that the Duncan may prove to be Pennsylvanian, but probably the greater number of the men who have studied the problem are of the opinion that there is at least one (possibly two or more) unnamed Permian units below the Duncan in this region. For these reasons the entire matter is held in abeyance.

On the map submitted herewith (Fig. 1), an attempt has been made to outline the areal geology of this part of the state as it is now understood. Detailed work not possible at this writing will doubtless modify the location of certain formation boundary lines.

Duncan sandstone.—The Duncan sandstone was first mentioned by Wegemann,[1] who described a prominent scarp-forming sandstone, crossing Stephens County, Oklahoma, from east to west, passing just north of the city of Duncan; whence the name. In describing the Duncan (Cruce) gas field, Wegemann says:

> The most important bed or group of beds in the Duncan field structurally and stratigraphically is a series of sandstones and interbedded shale about 40 feet in thickness, which forms an escarpment that partly encircles the field. The surface of the bed is in most places timber covered, and the line of wooded hills produced by its outcrop is a conspicuous topographic feature. The individual beds of the group are variable in thickness and extent, but the group as a whole covers a broad area and has been traced for about 60 miles from a point north of Foster, a small settlement 18 miles east of the Duncan field, to the north flanks of the Wichita Mountains. The sandstone in the Duncan field is white, but in part of the adjoining area is pink or red, and there are places where the change from pink to red may be observed in a single outcrop. This sandstone group forms the best horizon marker in the region and it is by means of it that a considerable part of the structure in the Duncan field has been determined.

[1] *Loc. cit.*

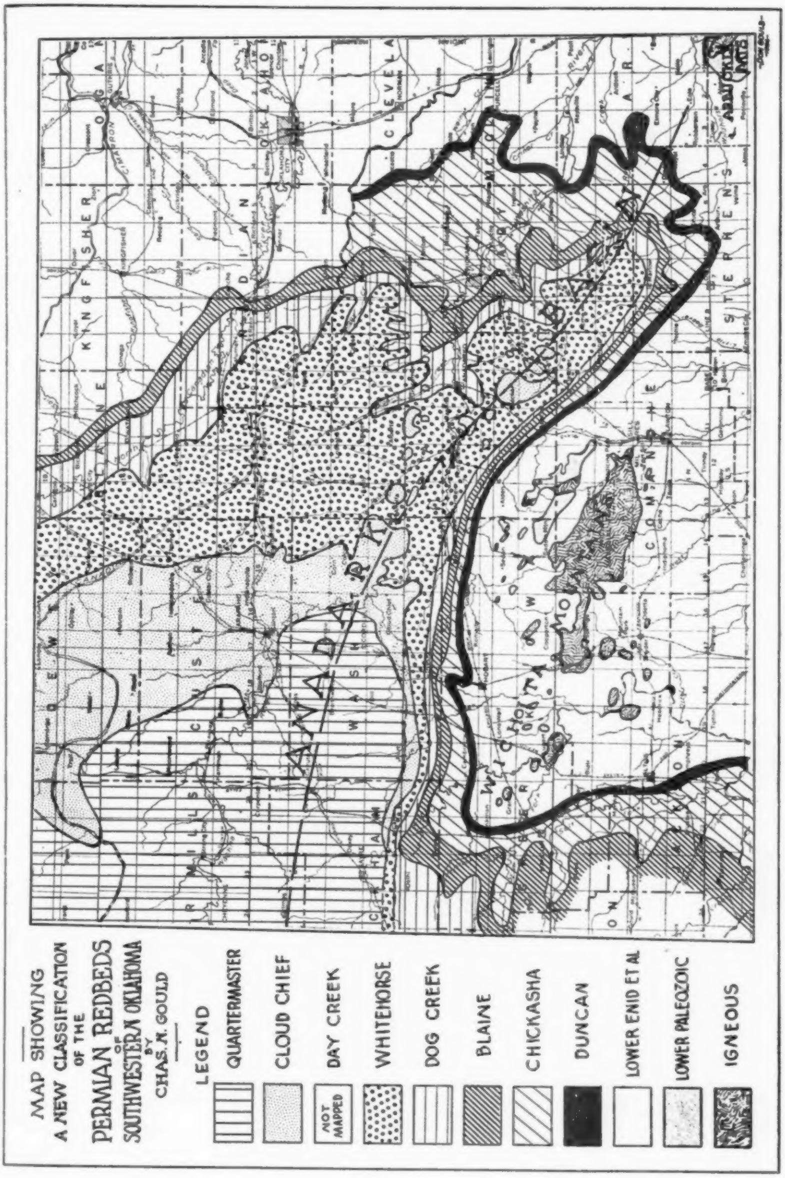
MAP SHOWING
A NEW CLASSIFICATION
OF THE
PERMIAN REDBEDS
OF
SOUTHWESTERN OKLAHOMA
BY
CHAS. N. GOULD
LEGEND
QUARTERMASTER
CLOUD CHIEF
NOT MAPPED
DAY CREEK
WHITEHORSE
DOG CREEK
BLAINE
CHICKASHA
DUNCAN
LOWER ENID ET AL
LOWER PALEOZOIC
IGNEOUS

Fig. 1

The Duncan sandstone finds its maximum development in the region near the southeast end or head of the Anadarko Basin in Stephens and Garvin counties, where it varies up to 250 feet in thickness, and consists of two or sometimes three ledges of heavy white or buff sandstone, sometimes dolomitic, separated by shales. Throughout this region it almost everywhere forms a prominent scarp, facing outward away from the axis of the basin. The most eastern exposure of this sandstone is on the Table Mountain in western Garvin County, from which the name "Table Mountain sandstone" has been applied locally to this formation. The presence or absence of continuous unconformities at either the base or top of the Duncan near the head of the Anadarko Basin is yet a mooted question.

On passing north from the point of maximum development, the Duncan sandstone soon begins to be less conspicuous, and can be traced with much difficulty. Several attempts have been made to follow this ledge northward across the Canadian rivers, but no two geologists seem to be able to agree as to the exact location of the northern extension of the Duncan in this region. The difficulty evidently is not with the geologists, but with the geology, being incident to the lenticular nature of the beds. It has been suggested by Aurin, Beede, and others that it may eventually be possible to trace the Duncan northward across central Oklahoma, and connect it with the Harper sandstone of Cragin's southern Kansas section.[1]

To the west of the type locality on the south side of the Anadarko Basin, the Duncan forms a more or less conspicuous scarp, crossing northeastern Comanche, southwestern Caddo, and northern Kiowa counties, as far as North Fork of Red River. Throughout a considerable part of this distance, it parallels the north flank of the Wichita Mountains at a distance of from 6 to 15 miles from the outcrop of the older rocks. In northern Greer County, northwest of the Wichitas, the sandstone becomes less conspicuous; its outcrop there runs south, passing a point a few miles east of Brinkman. In the vicinity of Altus and Elmer, Jackson County, south of the west end of the Wichitas, there is a sandstone occupying approxi-

[1] *Loc. cit.*

mately the same stratigraphic horizon as the Duncan, which has been found by Beede to continue for more than 200 miles into Texas.

Chickasha formation.—Lying above the scarp-forming Duncan sandstone is a series of sandstones and shales occupying the same stratigraphic horizon, but varying considerably in lithological character from place to place. For this formation the name "Chickasha formation" is proposed, from the city of the same name which is built on this formation. Near the southeastern end of the Anadarko Basin, the Chickasha formation is composed of about 175 feet of variegated sandstones and shales. On account of the predominating color of the rocks, the local name, "purple sandstone," has been used for this formation by geologists in this region. Mr. Clyde Becker, who at the present time is probably more familiar with the rocks of this locality than any other geologist, states that three divisions may be recognized in the purple sandstone (Chickasha) as follows:

1. An upper purple sandstone member 70 to 80 feet thick, the upper 30 feet of which consist chiefly of loose pink sand in which occur numerous thin lenses of purple "mudstone conglomerates"; the lower portion consists of 40 to 50 feet of heavy purple "mudstone conglomerate" beds separated by thin strata of pink sand.

2. A middle pink sand member consisting of 50 feet of uncemented pink sand. Occasionally this sand shows cementation on both upper and lower contacts. But the lithologic characteristics are the same as of the pink sand, and not similar in texture or color to the "mudstone conglomerates."

3. A lower purple sandstone member chiefly composed of "mudstone conglomerates," 50 feet thick, more distinctly stratified than any other portion of the Purple Series.

Mr. J. V. Howell, who has studied these beds carefully, kindly sends the following description:

The "purple sandstone" consists of a series of soft purple, greenish, gray, or red sand and sandstones, similarly colored shales, reddish or brown mudstone conglomerates. Sometimes, as in the north half of Township 4 North, Range 6 West, containing fairly definite and mappable ledges; or as in much of Township 4 North Range 5 West, consisting of a seemingly hopeless confusion of lenses, and with all of the characteristics of a shallow water deltaic deposit.

The coarseness, confused bedding, sharp and irregular changes in lithologic character and color, and preponderance of coarse clastic sediments indicate

deposition near the source of material, which at this time probably was near the west end of the Arbuckles. The purple beds at the head or southwestern end of the basin are thicker, coarser, more heterogenous than the corresponding beds to the west and northwest.

On passing north from the head of the Anadarko Basin, the Chickasha rocks gradually change into brick-red shales which characterize the upper Enid. In southern Kansas, Cragin named the rocks of approximately the same stratigraphic position the "Flower Pot shales."[1] If, however, as suggested previously, it proves feasible to connect the Duncan with the Harper, then the Chickasha will prove to be the stratigraphic equivalent of the Flower Pot, Cedar Hills, and Salt Plains Measures of Cragin. In the region extending along the base of the Gypsum Hills, from northwestern Canadian County, northward to southern Kansas, the rocks of the Chickasha formation consist chiefly of bright red shales, with splotches and bands of white and green shale, and considerable amounts of gypsum, usually in the form of concretions, selenite, and satinspar. The Salt Plains of Blaine and Woodward counties (not to be confused with Cragin's Salt Plains Measures) are located in this horizon.

On the south side of the Anadarko Basin in western Stephens, Comanche, Caddo, and Kiowa counties, the Chickasha is represented by a narrow band of red shale, lying immediately above the Duncan scarp. On account of the absence in this region of the identifying rock gypsum in the next higher formation, the Blaine, it is not always possible to separate these two formations. Near Cedartop Hill in extreme northwestern Kiowa County, and along the Gypsum Hills of southeastern Beckham, Greer, Harmon, and Jackson counties, the Chickasha occupies the interval, near the base of the Gypsum Hills, between the outcrop of the Duncan sandstone and the lower heavy gypsum member of the Blaine. Here, as in northern Oklahoma, the Chickasha rocks are predominatingly red clays with light bands, and concretions of gypsum. The old Kaiser and Chaney Salt Plains in northern Harmon County and the Salt Plains southeast of Carter, Beckham County, are in the Chickasha formation.

[1] *Loc. cit.*

Blaine gypsum.—This formation as first described by the writer in 1902,[1] and modified in 1905,[2] includes the series of gypsums, dolomites, and interbedded red shales, which make up the Gypsum Hills of northwestern Oklahoma, extending from Canadian County, northwest to the Kansas line. Throughout the greater part of this area there are three ledges of massive gypsum, varying up to 18 feet in thickness. In ascending order these gypsums are known as the Ferguson, Medicine Lodge, and Shimer. The Ferguson which, in northwestern Canadian County, is the thickest and most prominent of the three members, gradually thins to the north, until in the vicinity of the Glass Mountains in Major County it has lost its identity as a ledge, and its place is represented by a gypsiferous band in the red clays.[3] According to Snider, it is present as a distinct ledge in Woods and Harper counties. The middle gypsum ledge, the Medicine Lodge, which is usually thicker than the others, and is the chief cliff-maker of the Gypsum Hills, consists in places of anhydrite. The upper gypsum, the Shimer, is usually less conspicuous than the Medicine Lodge. From the type locality of the Blaine, which is in Salt Creek (Henquenet's) Canyon in northern Blaine County, this formation can be traced northward into Kansas until it finally disappears under the High Plains Tertiary, along the Medicine River in northwest Barber County.

From the type locality, the Blaine can easily be traced southeast for about 40 miles. In the northwestern part of Canadian County, however, the heavy gypsums become thinner and less conspicuous, until in the vicinity of Concho, El Reno, and Union it is often difficult to map the formation accurately. The majority of the members of the conference were agreed, however, that the formation extends across this region. Fossiliferous dolomites occur at the horizon of the Blaine, 5 miles south of El Reno. Rocks of the same stratigraphic position carrying gypsum occur in the hills west of Minco and Pocasset, and have been traced across the region

[1] "General Geology of Oklahoma," *Second Biennial Report, Department of Geology and Natural History, Territory of Oklahoma* (1902), pp. 17–74.

[2] "Geology and Water Resources of Oklahoma," *U. S. Geol. Survey Water Supply Paper 148* (1905).

[3] *Loc. cit.*

southwest of Chickasha and Ninnekah to connect with the Blaine horizon exposed near Bailey at the head of the Anadarko Basin.

Along North Fork of Red River, typically on Cedartop Hill, in extreme northwestern Kiowa County, also in southern Beckham and in Greer counties, there is exposed a series of gypsum beds with interbedded shales and dolomites, which was described under the term "Greer formation." In these localities there are usually five ledges of gypsum, separated by red clay shales, which, in ascending order, were named Chaney, Kaiser, Haystack, Cedartop, and Collingsworth members. Above the Collingsworth gypsum is a ledge of dolomite known as the "Mangum dolomite."

The Greer was divided into two general areas, the eastern and the western. The eastern area included the gypsum exposed along what is now recognized as the Anadarko Basin, chiefly in Caddo and Washita counties, thence northward along the northern limb of the syncline in Custer and Dewey counties. The western area included the type section at Cedartop and along North Fork, and the heavy gypsums in the Gypsum Hills of old Greer County. In citation of the fact that the writer was not at that time positive of his correlation in the territory in southern Washita County, the following quotation is offered from page 64, *Water Supply Paper No. 148*.

> The rocks of the Cedartop area appear to connect with those of the eastern area in southwestern Washita County, although throughout the region between Cloud Chief and the southwestern part of the country across the valleys of the various branches of Elk Creek, the gypsums ordinarily do not appear. However, at several points along the line of strike, ledges 10 feet or more in thickness may be seen in canyons or along stream beds.

Work by various geologists, chiefly Greene,[1] Beede, Hughes, and the writer, has shown that this correlation is incorrect. It is now known that in fact the gypsums at Cedartop and along North Fork may not be correlated with the so-called "eastern area" of the Greer, but are separated from the gypsums of this area by two intervening formations, the Dog Creek and the Whitehorse, which here occur in regular sequence. It is by no means easy to trace eastward the horizon containing the gypsums so well exposed at Cedartop,

[1] *Loc. cit.*

for, beginning a few miles east of this type locality, there are relatively few exposures of gypsum ledges on the surface. Careful work over a considerable area, however, has shown that the gypsiferous zone comprising the Blaine formation extends eastward and southeastward at the regular interval above and parallel to the Duncan and Chickasha formations, across northern Kiowa, southern Washita, southwestern Caddo, and northeastern Comanche counties, and swings around the head of the Anadarko Basin. In following this line of outcrop it sometimes happens that for a distance of several miles no heavy ledges of rock gypsums may be seen on the surface. Dr. Beede is authority for the statement, however, that core-drilling in southern Washita County shows the subsurface presence of seven to nine gypsum ledges of the Blaine in proper sequence and at the expected horizons. In other words, the gypsum, while often absent on the surface, is actually present underground. In this region ledges of dolomite on the surface mark the location of the Blaine.

At the head of the Anadarko Basin, gypsum is present in a number of localities at the horizon of the Blaine. In southeastern Grady and northeastern Stephens counties, two and sometimes three ledges of massive gypsum or gypsiferous sandstone, averaging 5 feet in thickness, occur in a zone about 50 feet thick. This zone represents the basal part of the Marlow formation, as the latter term has been known locally by Sawyer and other geologists.

To summarize: The Blaine formation, as it now is known, extends from Barber County, Kansas, into northern Oklahoma, thence southeastward along the scarp of the Gypsum Hills, past Salt Creek Canyon, the type locality. Continuing southeast it crosses the divide between the waters of Cimarron and North Canadian rivers, north of El Reno. It is present on the flat plain south of El Reno, crosses the South Canadian above Minco, is exposed in the hills west of Pocasset, and may be followed to a point near Bailey in southeastern Grady County. It swings around the head of the Anadarko Basin, and is believed to be present along a line north of the Duncan sandstone and parallel to the line of outcrop of this formation crossing North Fork of Red River in northwest Kiowa and southern Beckham counties. Thence it continues

south across Greer and Jackson counties into northern Texas and may be traced as far as Concho River in the west central part of that state. In the absence of more definite information, the Shimer is provisionally correlated with the Collingsworth, the Medicine Lodge with the Cedartop, and the Ferguson with the Haystack members of the Blaine.

Dog Creek shale.—Lying conformably above the Blaine formation is a series of red clay shales first described by Cragin in Clark County, Kansas, and by him named the "Dog Creek shales."[1] Its thickness in the type locality in Kansas is reported to be about 30 feet, but it thickens to the south and in Woodward County is 225 feet thick. Still farther south in Blaine and adjoining counties, its entire thickness cannot be measured at any one place, but it is believed to be still thicker, possibly 400 or 500 feet. Throughout the region of the Gypsum Hills, the Dog Creek occurs just above the gypsum ledges of the Blaine formation, occupying the position between the gypsum beds and the Tertiary (?) sands which cap the hills to the west. It crosses North Canadian River in the vicinity of Fort Reno and occurs in the bluffs along South Canadian River west of Union, and in the hills of northwest Grady County, west of Minco and Pocasset. It may be seen along the bluffs on both sides of Washita River between Verden and Anadarko, where it underlies the Whitehorse sandstone which in this region occurs higher on the hills. The Dog Creek outcrops near Norge, and in the Chickasha gas field, and passes southeast a few miles east of Rush Springs, swings around the head of the Anadarko Basin, and thence continues west and northwest parallel to the other formations, at least as far as eastern Beckham County. In the vicinity of Mountain View the thickness of the Dog Creek as shown in wells is about 400 feet. In southern Grady and northern Stephens counties, the shales which constitute the Dog Creek have been referred to locally, by Sawyer and others, as the upper part of the Marlow formation.

Parenthetically, it may be stated that along the line of outcrop on the southwest side of the Anadarko Basin, between Duncan and Hobart, it is not always possible in the field to draw a sharp line of distinction between the three formations last described, the Chicka-

[1] *Loc. cit.*

sha, Blaine, and Dog Creek. The subjacent Duncan, which forms a pronounced scarp, is usually distinguishable, and the Whitehorse, next higher in the series, may rarely be mistaken, but, on account of lack of proper exposures, these three beds which lie between the Duncan and the Whitehorse are often difficult to differentiate.

An unusual phase of the Dog Creek formation is a line of very peculiar, fossiliferous, conglomeratic sandstone exposures, which have the appearance of an old stream-channel occupying a more or less definite horizon in the upper part of the formation.[1] This sandstone is usually spoken of locally as the "Channel sandstone," or the "Footprint sandstone," the latter name being derived from some prehistoric carvings (?) of gigantic footprints on a bowlder of this sandstone about 6 miles east of Rush Springs.

The main line of outcrops of this phase of the formation, so far definitely located, extends northwest from a point southeast of Rush Springs, for a distance of about 40 miles, to a point some 12 miles north of Verden. Throughout this distance the deposits are in almost perfect alignment and often resemble a railroad grade extending across the county. The ledge is rarely more than 10 feet thick or more than 500 feet wide. It is composed of small pebbles and sand grains, evidently derived from adjacent formations, cemented with calcium and magnesium.

This phase of the Dog Creek formed the subject of a thesis for the Master of Art's degree by Mr. Norman Meland at the University of Oklahoma, and a description prepared by Mr. Meland and Mr. R. D. Reed has just appeared in the *Journal of Geology*. By them it is named the "Verden sandstone." Therefore, only this brief mention need be made at this time.

Whitehorse sandstone.—Most geologists who have studied the problem believe that there is a continuous unconformity between the top of the Dog Creek and the base of the Whitehorse. Exposures of the contact are not always present, however, so that at this writing the question must be left open.

The Whitehorse sandstone was named first "Red Bluff sandstone" by Cragin, from a prominent exposure in Comanche County, Kansas. When the manuscript was submitted for publication as

[1] Frank Reeves, *loc. cit.*

Water Supply Paper No. 148, the committee on geologic names at Washington ruled that the name "Red Bluff" was preoccupied, and therefore the present name, "Whitehorse," was substituted.

The Whitehorse outcrops over a larger area than does any other formation in the region under discussion. With the exception of the Day Creek and Cloud Chief formations, which are comparatively thin, the Whitehorse is the highest formation occurring along the main axis of the Anadarko Basin; and in those places where the Day Creek and Cloud Chief are absent, the Whitehorse occupies a continuous exposure across the axis of the basin. From the vicinity of Fort Cobb and Anadarko, southeast to the head of the basin, a distance of about 45 miles, the width of the area occupied by the Whitehorse averages 15 miles. From these towns northward, for a distance of 50 miles or more, the width of the area of outcrop will average perhaps 25 miles. Westward from Fort Cobb, along the south side of the Anadarko Basin where the dips are steeper, the Whitehorse is exposed as a comparatively narrow band, averaging 2 to 4 miles wide. The Whitehorse also occurs in a narrow belt in northern Harmon County.

The Whitehorse throughout the greater part of its areal extent in Oklahoma consists typically of friable, red, cross-bedded to regular-bedded sandstone, which weathers rapidly, producing a thick sandy soil. The thickness of the formation is not always easy to determine, but, in the region being discussed, varies from 200 to 300 feet, averaging, according to Reeves, about 250 feet in the Cement region. The sandy soil gives rise to typical sandhill vegetation. For a very comprehensive description of the Whitehorse sandstone and its probable origin, reference is made to the article by Reeves.[1]

The writer now believes that the dolomite which forms the summit of the Red Hill at Greenfield, Blaine County, is not Day Creek, as first indicated by Cragin,[2] but is, in fact, a dolomitic member occurring in, and not far above, the base of the Whitehorse. The typical Day Creek occurs in the vicinity of Thomas some 20 miles

[1] *Loc. cit.*

[2] "Observations on the Cimarron Series," *American Geologist*, Vol. 19 (1897), No. 5, pp. 351 ff.

west of Greenfield, and at a higher elevation than the dolomite exposed on Red Hill.

Day Creek dolomite.—At the upper limit of the Whitehorse sandstone is usually found a ledge of hard massive dolomite, which Cragin named the "Day Creek dolomite."[1] In thickness it varies up to 5 feet, or occasionally there are two distinct ledges of dolomite 2 to 4 feet thick each, separated by red shales. In color the dolomite is usually white, sometimes pinkish. Being harder and more resistant than any other rock in the redbeds, the Day Creek weathers typically into scarps, hills, and buttes, which dominate the landscape throughout its line of outcrop.

In the region under discussion, the most conspicuous exposures of the Day Creek dolomite are on the Caddo County buttes, located in northern Caddo County, chiefly along the divide between Washita and South Canadian rivers. These buttes, more than a score in number, are formed of Whitehorse sandstone capped with Day Creek dolomite. The formation is also found in the hills near Weatherford, where it marks the boundary between the Whitehorse and the Cloud Chief. Farther southwest in southern Washita County, the Day Creek is absent, or at best is represented by an inconspicuous dolomitic zone at the top of the Whitehorse.

Cloud Chief formation.—This formation, as now understood, includes what was originally described as the "eastern area" of the Greer. It lies above the Day Creek dolomite where the former is present, or, if the Day Creek is absent, it is next in succession above the Whitehorse sandstone.

The name "Cyril" was used for this gypsum in the Cement area by Clapp,[2] who erroneously considered it to be the equivalent of the Blaine. The underlying Whitehorse he classified as Enid. Reeves recognized Clapp's error in correlation, but himself falls into error when he states that "only the basal part of the Greer is present in this area, where it is represented by the Cyril gypsum member."[3] In point of fact, so far as can be determined, the entire Greer (as the term has heretofore been used) is present at Cement. Because of the fact that both geologists who have used the name

[1] "The Cimarron Series of Kansas," *Colo. Coll. Studies*, Vol. 6 (1896), pp. 4 ff.

[2] *Loc. cit.*

[3] *Op. cit.*, p. 48.

Cyril in type have fallen into error in the use of the term, in order to avoid additional confusion, it appears to be wise to introduce an entirely new name. Therefore, for this formation the name "Cloud Chief" is proposed. The name is from a town in eastern Washita County (formerly the county seat), near which place the formation is typically exposed.[1]

The Cloud Chief formation consists of ledges of massive gypsums imbedded in red shales. The gypsums vary much, both in number and thickness. In some places, as for instance near Cement, there are, according to Reeves, two beds separated by 15 to 20 feet of gypsiferous shale. The upper bed here varies in thickness up to 85 feet, but the average thickness of the two beds in this region is perhaps not more than 5 feet. In other localities three or more gypsums, separated by clay shales, outcrop on the surface.

The maximum development of the gypsums of the Cloud Chief is along the axis of the Anadarko Basin in eastern Washita County where near Cloud Chief and Colony, ledges 100 feet thick have been measured on the surfaces, and where a thickness of 115 feet has been reported in wells.

The Cloud Chief is exposed along the axis of the Anadarko Basin from a point about 6 miles south of Cement in southeastern Caddo County, thence northwest diagonally across southern Caddo County as far as eastern Washita County. The line of outcrop crosses the Washita River near Fort Cobb. Throughout this area, however, the exposures on the surface are not continuous, erosion having removed the Cloud Chief over considerable areas, exposing the underlying Whitehorse, which here forms the surface formations. The Cloud Chief occurs chiefly in isolated exposures along streams and bluffs, but does not usually form continuous ledges at the surface, as in the case of the Blaine gypsum.

In eastern Washita County the surface exposures of the Cloud Chief divide, one limb passing north, the other west, along the two sides of the Anadarko Basin. The northern limb continues across

[1] The frontispiece of Governor Barnes's report as Governor of Oklahoma to the Secretary of the Interior in 1899 is a picture of this ledge of gypsum along the Washita River at Cloud Chief, this being (with the exception of Marcy's Red River report, in 1852) the first appearance of this gypsum bed in literature.

Washita, Custer, and Dewey counties, as far as southern Woodward, and its stratigraphic equivalent is believed to be present along Beaver Creek in Beaver and Texas counties.

The southern limb of the Cloud Chief passes west across southern Washita County, being exposed on the surface in a few scattered localities a few miles north of Rocky and Sentinel, and passes beneath the sandhills in southeastern Beckham County. It was the attempt to trace this gypsum bed across this region of few exposures and connect with the conspicuous gypsum ledges, now known to be Blaine, at Cedartop, that caused the confusion in the correlation of the redbeds in this part of Oklahoma. Dr. Beede states that core-drilling in the Sentinel-Rocky country shows five distinct ledges of Cloud Chief gypsum interbedded with sandy shale. Mr. Miser states that the Cloud Chief is the surface formation over parts of several townships in northern Harmon County, where it lies in a syncline.

According to Dr. Beede, there is a well-marked unconformity at the base of the Quartermaster formation, representing a period of erosion. It is believed by him that this erosion has beveled off the Cloud Chief gypsum in southwestern Roger Mills County, so that in progressing westward the Quartermaster rests, in turn, upon the eroded portion of this formation and upon the underlying Whitehorse.

The following log of a well, located on Sec. 9, T. 8 N., R. 15 W., 7 miles northwest of Mountain View, will show the approximate thickness of the various formations from the Cloud Chief to the Duncan, along the south side of the Anadarko Basin north of the Wichita Mountains (interpretation by Mr. C. Don Hughes).

Formation	From	To	Thickness
Cloud Chief..........	0	50	50
Whitehorse...........	50	415	360
Dog Creek...........	475	825	410
Blaine...............	825	945	120
Chickasha............	945	1,240	295
Duncan..............	1,240	1,315	75

Quartermaster formation.—The term "Quartermaster" has been used to describe the upper formation of the Permian as exposed in

western Oklahoma and the Panhandle of Texas. This formation, which has a known thickness of about 300 feet, consists typically of soft, red sandstones and sandy clays and shales. In the area herewith discussed, it is exposed in western Washita and Custer and eastern Roger Mills and Beckham counties. To the west the Quartermaster is overlaid by the High Plains Tertiary and sand dunes.

SUMMARY

The results of the January, 1924, field conference on the redbeds of southwestern Oklahoma include the following changes in classification and mapping:

1. The former classification of the redbeds, on the basis of the presence of gypsums, has been abandoned, and the new classification on the basis of unconformities is adopted.

2. Two new formations are added, the Duncan sandstone and the Chickasha formation, both of which are the stratigraphic equivalent of the upper part of the Enid.

3. The Blaine formation has been mapped as continuing around the southeast end of the Anadarko Basin and has been correlated with the so-called "western area" of the Greer at its type locality at Cedartop Hill and along North Fork of Red River in southern Beckham County.

4. The Dog Creek shales and Whitehorse sandstone are also found to continue around the Anadarko Basin, and may be traced as far as the North Fork of Red River in southern Beckham County, and appear in Harmon County. The Verden sandstone, a peculiar phase of the Dog Creek, is recognized.

5. The name "Woodward," which had formation rank, is abandoned, and the three units, Dog Creek, Whitehorse, and Day Creek, previously considered members of the Woodward, have been advanced to the rank of formations.

6. The name "Greer" is abandoned. For the so-called "eastern area" of the Greer, the name "Cloud Chief" is proposed. It is shown that the rocks in the "western area" of the Greer belong to the Blaine, Dog Creek, Whitehorse, and Cloud Chief formations.

7. A structural trough, known as the Anadarko Basin, is recognized as extending northwest from a point near the west end of the Arbuckle Mountains for a distance of more than 150 miles.

8. Since it has been found that a conglomeratic sandstone, which in Texas occurs at the base of the Double Mountain, as that series of rocks was first described by Cummins in 1901, is the same bed as the Duncan sandstone of Oklahoma, it follows that the formations described in this paper, from the Duncan to the Quartermaster inclusive, are the stratigraphic equivalents of the Double Mountain, the uppermost Permian division of Texas.

GEOLOGICAL NOTES

BENTONITE IN THE UPPER CRETACEOUS OF LOUISIANA[1]

Bentonite is the name applied to an altered volcanic ash, this rock being characterized by the dominant mineral leverrierite, a hydrous silicate resulting from the alteration of the fine volcanic ash or mud.

This material is particularly valuable as a horizon marker. It can be easily and certainly recognized by the physical and mineralogical properties described later in this paper. The bed or zone is apt to be of wide extent, as are recent volcanic ash falls and other known occurrences of bentonite. The deposit would have essential contemporaneity throughout this extent, as such material from a volcanic explosion would be quickly transported and deposited. Some knowledge of the transporting agencies, such as winds and ocean currents, as well as the location and magnitude of the volcanic center, may be gained if sufficient data on the occurrence of the bed are obtainable.

The first recorded occurrence of bentonite in Louisiana is from a core sent to the Geological Survey by Mr. H. D. Easton, of Shreveport, Louisiana. Fossils obtained in the well near the bentonite enter Arkadelphia or Marlbrook of Upper Cretaceous age. Bentonite occurs in the Taylor marl (Upper Cretaceous) of south-central Texas, and it is very widespread in the Upper Cretaceous of Wyoming and adjacent states; in this latter occurrence the material can be traced over hundreds of square miles, although individual beds rarely persist for more than a few miles. This suggests that in Louisiana bentonite may also be in a zone rather than in a single persistent bed. It is possible that there are other bentonite horizons in north Louisiana lower in the section which might correlate with the Texas occurrence or with the tuffs in the Bingen of Arkansas. An occurrence has been described by W. A. Nelson in the Ordovician of Tennessee, Kentucky, and Alabama. At High Bridge, Kentucky, this bed averages 5 feet in thickness; in Tennessee it is 3 to 4 feet, and at Birmingham, Alabama, only a little over 1 foot. The bed is estimated by Mr. Nelson to cover an area perhaps 800 miles long by 450 miles wide.

[1] Published by permission of the Director, United States Geological Survey.

This bentonite from Louisiana is an impure material of greenish gray color showing the characteristic properties of slacking and swelling with the absorption of up to seven times its volume of water. These properties are due to the dominant mineral, leverrierite, which is probably an alteration product of volcanic glass, as in other cases. There are many quartz grains up to .75 mm. in diameter, and these show a whitish film or incrustation on the surface; the quartz is probably an admixture of detrital grains, and not a part of the volcanic ash. Some orthoclase and acid plagioclase are present, usually as prismatic cleavage fragments; these are all perfectly clear and unaltered. Some relatively large grains of altered pumiceous igneous rock showing vesicular cavities are present. The accessory minerals include many zircons, often well rounded; ilmenite as angular grains; a little rutile and brown amphibole, also occasionally well-rounded; some brown tourmaline grains; and a few irregular grains of pink garnet. Much calcite is present as secondary veinlets, usually approximately parallel to the bedding, and associated with this is much siderite as an incrusting material. Much of the admixed sand seems to be detrital material from a different source than the volcanic ash, probably representing the transition material from the ash bed to the ordinary clastic sedimentary rocks, and it is possible that this bed may contain less of these sand-size grains and be a purer bentonite within a few inches or feet vertically.

A core sample of the material should be easily recognized by the physical properties, as a fragment placed in water shows the rapid slacking, swelling, and absorption of water in a more marked degree than any clays, though these changes are much less marked in strongly saline water. In thin section the leverrierite may be recognized by the characteristic vermicular or wormlike aggregate forms and radial spherulitic forms, which are assumed by the minute crystals. In order to prepare a thin section of such soft rock some such preliminary treatment as soaking in bakelite for about a day and then baking for several days at about 90° to 100° C to harden the sample, is necessary.

In drilling it may be impossible to be sure when this material is encountered, especially with rotary tools, as it will slack and mix with the drill mud, though some might be preserved in the returns if the water were strongly saline.

If this bentonite is to serve as a valuable horizon marker in northern Louisiana and southern Arkansas, it is important that both its exact stratigraphic position and its lateral extent be determined. It therefore seems justifiable to urge geologists working in territory where it

might be present to watch closely for it, and to secure cores both from the bentonite itself and from the beds above and below it, so that there may be paleontologic evidence to place it accurately in the stratigraphic column. Figures on thickness of the bentonite zone should also be secured, as they are essential if the source of the ash is to be ascertained. Any observed occurrence of this zone should be made a matter of record through publication.

M. N. Bramlette
U. S. Geological Survey

December, 1923

VOLCANIC ROCKS IN THE CRETACEOUS OF LOUISIANA[1]

The occurrence of a succession of volcanic tuffs and flows more than 1,000 feet thick beneath the "gas rock" in the Monroe gas field has been determined by the study of a series of cores from a well, drilled by the Palmer Corporation, in this field. Bentonite, an altered volcanic ash, has recently been noted at about the same horizon in a well northeast of the field.

Examination of cores shows that these volcanic rocks occur 120 feet below the limestone "gas rock" and the rock descriptions of the driller's log suggest that they extend up to about the base of this limestone. The "gas rock" has been generally assumed to be the Annona chalk, but it is quite possible that it may be a limestone facies of a higher formation, such as the Marlbrook marl or the Nacatoch sand. This limestone contains many orbitoid foraminifera of probably two or more species that should prove of value in a correct correlation with further work, though at present the names and ranges of these American Cretaceous *Orbitoides* is not worked out. Outcrop samples from the Annona tongue of the Austin chalk in Arkansas and northeast Texas were studied by the writer, but no orbitoid foraminifera were found. This negative evidence is of little value, but the fact that the genus *Orbitoides* in Europe is first found in the lower Campanian, which would be about the equivalent of the Annona, and only attains its maximum in the Danian, which is younger than the Arkadelphia, suggests that the "gas rock" horizon is higher than the Annona.

Below these volcanic rocks there is a little over 200 feet of shales, sandy shales, thin sandstones, and argillaceous limestones that contain many fossils at certain horizons. The fossiliferous cores were submitted

[1] Published by permission of the director, United States Geological Survey.

to Dr. T. W. Stanton, of the Geological Survey, who stated that "These fossils belong to the Comanche fauna and most probably indicate the Washita, or uppermost group of the Comanche." Beneath these beds are red shales, some of them sandy. A fossiliferous limestone within the red beds contained fragments of Ostrea which were not specifically determinable but which indicate Comanche age.

The Bingen in Arkansas is known to contain volcanic tuffs somewhat similar to those here described, but much thinner. It is evident that the exact correlation of these formations will require more paleontologic work, but the 1,100 to 1,200 feet of volcanic material in the Monroe field seems to include the interval between the Nacatoch, Marlbrook, or Annona and the Washita (of Comanche age). It is quite probable that the accumulation of this volcanic rock would not require as much time as the accumulation of an equal thickness of normal marine sediments represented by the previously named formations, and so the volcanics may represent the Bingen only, and subaerial conditions with non-deposition may have prevailed during Brownstown and later times, up to the time of the marine deposition of the "gas rock." The presence of a red oxidized zone in the volcanics is suggestive of a period of aerial exposure and weathering.

This volcanic series consists largely of tuffs, but there are associated flow rocks or lavas, at least in the lower few hundred feet. The lavas are brownish gray to grayish white, highly altered rocks consisting of a fine ground mass and relatively large feldspar phenocrysts. In the ground mass there is a remarkable development of many interlocking prismatic crystals of apatite and because of the extreme alteration this is the only recognizable original mineral. The feldspar phenocrysts are so completely altered that their original nature is indeterminate. Calcite and zeolites are the chief secondary minerals. The tuffs consist of fragments of various sizes up to several centimeters of this porphyritic flow rock and other fragments of a vesicular or pumiceous character. Mixed with these pyroclastics as a filling between fragments is much non-pyroclastic detrital material including fairly well rounded quartz grains. This quartz is evidently from a different source, as the igneous rock is quartz-free and the quartz grains occur only between the igneous fragments. The cavities and vesicles are generally filled with calcite and zeolites and much of the rock material is replaced by these minerals.

The large size of some of the volcanic rock fragments in the tuffs makes it in part more properly a volcanic breccia or conglomerate, and this character and the associated flow rocks are evidence of a comparatively

near-by source of the material. More data on the thickness of this series at other localities is necessary for fixing the center of eruption. That the rocks were deposited in water rather than subaerially seems probable, though no fossils could be found nor is there any bedding shown in the cores. However, the admixture of many detrital quartz grains which are fairly well rounded is more apt to have been a result of aqueous deposition, and the abundant development of calcite and zeolites is more probable under these conditions, as is the general lack of much oxidation.

Such a thick series of volcanics must certainly extend for a considerable distance laterally and will probably be found at this horizon over much of northern Louisiana, if not farther, though the thickness and lithologic character may vary greatly. Rotary cuttings of this material may be recognized by the many irregular cavernous fragments of altered igneous rock and many feldspar crystals, which are highly altered but retain their well-developed crystal form. Some obvious lithologic differences may serve for correlation within this series, though it is questionable how far laterally these may hold. A highly oxidized zone near the middle of the series, resulting in red tuffaceous rock, may maintain this character for some distance, as may the zones of uniform-textured, non-fragmental volcanic flow rocks occurring in the lower part of the series.

It is unlikely that such a thick series of volcanics contains source rock of petroleum, though its porosity is high and individual beds would serve well as reservoirs for oil or gas. If oil is anywhere found to occur in these rocks, its source would probably be in the underlying rocks of Comanche age and it would therefore be important to drill through this thick series to test these source rocks.

M. N. Bramlette

March 25, 1924

ADDITIONAL NOTE

Subsequent examination of well logs and of the few well cuttings and cores available from below the "gas rock" in other wells of the field has failed to discover these volcanics, and it seems evident that such a thick series of these rocks does not underlie the entire field. The occurrence is remarkable in its local nature, and the source must be very near, but as the material is largely pyroclastics, it seems certain that a bed of some thickness, at least, must occur over a large area, and that close watch of cuttings and coring will find this bed which would prove a most valuable horizon for correlations.

M. N. Bramlette

April 15, 1924

THE SAYRE FIELD, BECKHAM COUNTY, OKLAHOMA

The Sayre Field of Beckham County, Oklahoma, farther west than any oil field in the state, is situated in T. 9 N., R. 23 W., and is 18 miles east of the eastern edge of the Texas panhandle. The town of Sayre, which is the county seat of Beckham County, is only 3 miles north of the field. It has a population of about 3,000, and is a division point on the Chicago, Rock Island & Pacific Railway about midway between Oklahoma City and Amarillo.

The Twin Hills Oil Company, made up principally of local people, brought in the discovery well in the field in the SW. $\frac{1}{4}$, SE. $\frac{1}{4}$ of Sec. 15 during the month of July, 1922. The initial production was 50,000,000 cubic feet of gas and 20 barrels of oil from a sandy lime at 2,755–2,806 feet. Since there was no pipe line and no market for the gas, this well attracted very little attention, and development of the pool was delayed until the following year. In April, 1923, Martin, Kiskadden, *et al.* brought in a 200-barrel well in the NE. $\frac{1}{4}$ SE. $\frac{1}{4}$ NW. $\frac{1}{4}$ of Sec. 31. This well was located upon the recommendation of Mr. G. E. Pitts, a geologist, of Tulsa, Oklahoma. The well had 5 feet of sand from 2,955–2,960 feet. This well was later purchased by the Atlantic Oil Producing Company and deepened. It is now (March, 1924) producing about 35 barrels a day.

The present daily production of the field is 640 barrels from 8 wells, one of which (discovery gas well) is making only 7 barrels of oil and about 15,000,000 cubic feet of gas. More than 300 barrels of this production is being pumped from the Carter No. 2 Windle in the SE. $\frac{1}{4}$ NW. $\frac{1}{4}$ NE. $\frac{1}{4}$ of Sec. 31, which is the most recent completion in the field. There are 4 other gas wells, 10 drilling wells, and 11 dry holes. None of the dry holes can be considered as being between any of the producing wells. Distribution on the wells is shown in Figure 1.

The gravity of the oil is about 34° Baumé. It is purchased by the Atlantic Oil Producing Company, which has a pipe line to a point on the W.F. & N.W. Railway, about 15 miles southeast of the field. Posted prices for Mid-Continent crude are paid.

The entire field is covered with sand dunes and there are no surface outcrops, although the gypsums and dolomites of the Blaine formation,[1] of Permian age, outcrop about 3 miles south of Section 31. These beds are encountered at from 300 to 600 feet in the wells drilled in the field and form the most easily recognized horizon in the logs. Contours based on the top of the Blaine formation as found in the well logs show

[1] C. N. Gould, H. D. Miser, and others have recently determined that the Greer gypsum is really the Blaine.

an elongated dome with 100 feet of closure, with an axis running about N. 30° E. The wells in Section 31 are located on the extreme southwest edge of the dome, which extends to Section 15.

The production is found in sandy breaks in the "Big Lime," at about 2,950 feet. Several of these breaks, carrying shows of oil or gas, are usually found above the main pay. It is the opinion of the writer that the wells in Section 31 are producing from a lower sand than those farther north. The pay sand in Section 31 is about 800 feet below the

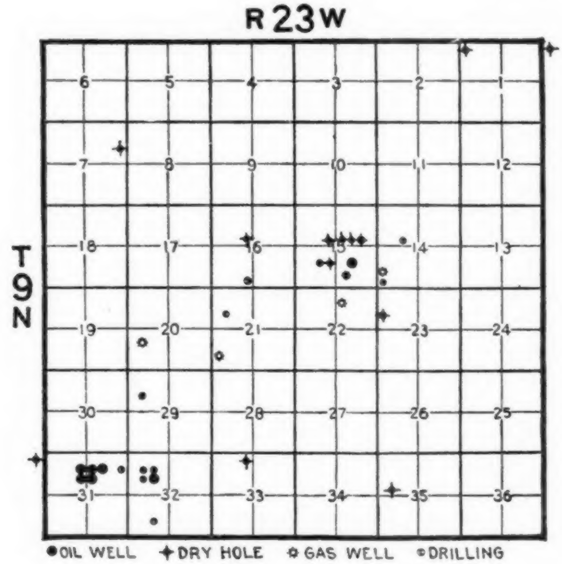

FIG. 1.—Map of Sayre oil field, showing production to April 15, 1924

top of the lime, which is believed to be conformable with the top of the Blaine formation. The interval from the top of the Blaine to the top of the lime is about 1,700 feet. The red beds, including the Blaine formation, are about 1,500 feet in thickness. There is an interval of blue shale, with some lime shells, between the bottom of the red beds and the top of the lime at 2,100 feet. The lime is found to be fairly solid in some of the wells, and very soft and broken in others, so that the actual top of the formation is very hard to identify in the rotary well logs.

The age of the "Big Lime" is somewhat uncertain. It is generally correlated with the "Big Lime" in the Amarillo gas field, on account of the constant interval below the gypsum. The Amarillo lime has been identified as Permian from fossils found in drill cuttings. Pennsylvanian fossils have been found in what appears to be the same lime in wells in southwestern Oklahoma, south of the Sayre field, and on the south flank of the Wichita Mountain uplift.

The producing sands are made up of small bits of lime, and of sharp angular pieces of broken quartz crystals. The percentage of lime in the sands varies from about 10 to 50, and in some wells may be even higher. These sands are usually quite porous, so that the wells may have a very large initial production and a very sharp decline. Several wells, which were high enough on structure to get production, failed to find the oil owing to a lack of the proper sand conditions. Although the field is about four miles long, and none of the dry holes are between any of the producing wells, any well drilled more than a location away from a producing well is strictly a wildcat venture, due to the uncertainty of finding the breaks in the lime.

Most of the wells at Sayre which are drilled to any great depth encounter granite wash or other igneous material, and in some cases find solid granite. Especially is this true of wells south of the field and nearer the axis of the Wichita Mountain uplift. In no case has production been found after igneous material was penetrated by the drill. Wells in or on the edge of the field, which have penetrated igneous material, are as follows: Magnolia, SE. $\frac{1}{4}$ SE. $\frac{1}{4}$ NW. $\frac{1}{4}$ Sec. 16, T. 9 N., R. 23 W., granite wash at 3,570 feet, granite at 3,917 feet; Magnolia NE. cor. sec. 36, T. 9 N., R. 24 W., wash at about 3,500 feet and granite at 3,906 feet (?); Foster, NE. $\frac{1}{4}$ NE. $\frac{1}{4}$ NW $\frac{1}{4}$, Sec. 33, T. 9 N., R. 23 W., granite wash at 3,230 feet; Rubanna, SW. $\frac{1}{4}$ NW. $\frac{1}{4}$ NE. $\frac{1}{4}$ Sec. 22, T. 9 N., R. 23 W., granite wash at 3,320 feet.

Most of the wells at Sayre are now drilled with rotary tools, since it has been found that the Big Lime offers no great difficulties in their use. Eight-inch casing is set on the sand, and cable tools are used to drill in. A "turnkey" rotary job on one of the recent wells cost $30,000. This included the string of casing and rig. The contract price per foot for drilling combination rotary and standard is $5.50. Gas from other wells in the field is used as fuel, and plenty of water can be obtained from surface wells at a depth of about 80 feet.

R. A. Birk

Ardmore, Oklahoma
April 12, 1924

PLANS FOR COMPILATION OF LOUISIANA-ARKANSAS GEOLOGY

The following plan for university graduate extension work to investigate and compile the geology of northern Louisiana and southern Arkansas, as proposed by Professor H. V. Howe, head of the geological department of Louisiana State University at Baton Rouge, who will conduct the work, has been unanimously approved by the Shreveport section of the Southwestern Geological Society of which A. F. Crider is chairman and F. J. Miller is secretary, and the first lecture of the course, on the Arkadelphia formation, was scheduled for April 4 at Shreveport.

SCOPE OF WORK

This extension work is designed primarily to form a permanent record of all that is known of the geology of northern Louisiana and southern Arkansas; to aid the petroleum geologists of Louisiana in solving their stratigraphic problems, while enabling them to continue their professional training; and, lastly, to place freely before the public in accessible form the essential geologic facts concerning the stratigraphy of the region designated.

PROCEDURE

First, it is proposed to establish a graduate seminar in geology which will meet at Shreveport on Friday and Saturday, every two weeks during the spring and fall terms of the school year. In this seminar will be discussed, by horizons, each of the formations of the Cretaceous and Tertiary of northern Louisiana and southern Arkansas, and this information will be plotted on large-scale base maps to form a basis for further study. It is proposed that students with proper qualifications may register for college credit which may be counted toward a Master's degree, the amount ranging from one to three hours per term, to be determined by the graduate committee. At least one term's work must be done in residence at Baton Rouge. It is proposed also that the initial registration fee for this course be \$20.00 for the first term, and \$10.00 for any additional term thereafter. Those desiring to avail themselves of the information afforded by this course, without college credit, may do so upon the payment of these registration fees. All base maps for this work are to be furnished by the Shreveport section of the Southwestern Geological Society and are to remain the property of the University.

Second, it is proposed to establish a branch of the geology department museum at Shreveport, in which will be placed such maps, logs, cores,

cuttings, rocks, and fossils as may shed light on the geology of northern Louisiana and southern Arkansas. This museum is to be only a field branch of the main geology department museum at Baton Rouge, and all material donated by the geologists and oil companies will be numbered and catalogued by the same serial numbers used in the main collections at Baton Rouge, and all duplicate material will be shipped to the latter place. The Shreveport section of the Southwestern Geological Society will furnish a suitable room in which to house this collection. In this regard, it is proposed that the University furnish a museum assistant, at a salary of $100.00 per month, to take care of, label, and catalogue these collections, it being understood that six months of the assistant's time is to be spent on the collection at Shreveport, and the other six months to be spent in caring for the main collections at Baton Rouge.

AGREEMENTS AND SAFEGUARD

The University reserves the right to move the geological collection from the Shreveport branch museum to the main museum in Baton Rouge at any time after the expiration of five years from the establishment of this course; or, in case the Shreveport section of the Southwestern Geological Society fails at the beginning of any spring term prior to 1929 to furnish the University with a certificate showing that the rent for the museum room has been paid for one year in advance, the University will have the privilege of moving all material in the Shreveport branch museum to the main museum at Baton Rouge.

It is further proposed that the University shall not undertake this work unless the Shreveport section of the Southwestern Geological Society shall officially agree to the above provisions relating both to the graduate seminar course, the branch museum of the Department of Geology, and the obligations which the section is to render in return for this service.

J. P. D. Hull

Shreveport, Louisiana
March, 1924

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[1] Published by permission of Acting Director, U. S. Geological Survey.

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BERTRAND L. JOHNSON[1]

[1] Assisted by Miss L. M. Jones and Miss M. F. McShea.

THE ASSOCIATION ROUND TABLE

THE HOUSTON MEETING

Just as the mounting curve of petroleum production in our country has climbed year by year to undreamed of heights, so the annual meetings of the American Association of Petroleum Geologists seem each to have outdistanced all of the past. How little did those of us who came together out of common interest in the problems of petroleum geology, back at Tulsa in 1917, and organized the nucleus of our present organization—how little did we imagine such a gathering as that at Houston, or such a society as ours today. All of which is by way of leading up to the declaration that those who couldn't or didn't get to Houston missed something, and to the prophecy that those who can't or don't manage to attend future meetings will probably miss something more.

We had been given to understand that plans for the Houston meeting were already in progress at Los Angeles, last fall, and we had been advised from time to time that preparations were going ahead vigorously. Nevertheless, when, setting aside the last week in March, we responded to Houston's invitation, we were hardly prepared for the fine time we found awaiting us. The local committee had lived up to advance notices.

The crowd of visiting geologists, many accompanied by their wives, began to arrive the day before the scheduled opening of the meetings, and by Thursday morning there was much more than a quorum present. Commodious facilities at the Rice Hotel for registration and meetings aided in getting things under way. Following greetings from the mayor of Houston and John Suman, president of the Houston Geological Society, the first technical session started, Max Ball presiding. The nature of the scientific contributions and discussions are indicated in the list of papers offered, which follows. An unusually large number of papers were read by title, an arrangement necessitated by the long program, plans for field trips and other activities, and the desire to avoid division of the meeting into sections. Many were disappointed that important and interesting papers were not read, and there was emphasized the desirability of having abstracts of the contributions represented by the titles.

A change in customary procedure was made in holding a business meeting in the latter part of the first morning session, and as reported in following pages, the election of officers and other business was transacted at this time.

The annual banquet, held at the Rice Hotel on Friday evening, was the largest and, in many ways, one of the most enjoyable affairs of the sort we have

had. Following a few not uninterestingly prolonged after-dinner dissertations, supervised ably by Jelmer Thomas, an elaborately planned and admirably executed comic opera with costumes, footlights, 'n'everthing, was presented to a very appreciative audience. A handsomely printed libretto, with color reproduction of an oil painting presented to the Association by R. B. Whitehead, made it easy to follow the "plot" and formed a unique souvenir of the occasion. We are informed by those who know, that the success of the banquet performance was largely due to Mr. Whitehead and certain members of his staff who designed, constructed, and operated the scenery, curtains, properties, and lights and handled all the burdensome duties attending a theatrical performance. After the entertainment, which concluded with a "rogue's gallery" of more or less well known Association members whose pictures (taken from thirty to forty years ago) were thrown on the screen, the floor was cleared and dancing was the program into the wee small hours.

The entertainment provided for the ladies was an admirable part of the arrangements at the Houston meeting. We have it on good authority that something very enjoyable was in progress morning, noon, and night, throughout the days of the sessions.

Attendance of members at the meeting, listed from the Secretary's registration, was as follows:

LIST OF MEMBERS REGISTERED AT NINTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS
HOUSTON, TEXAS, MARCH 27, 1924

Abrahamson, H., Denver, Colo.
Aid, Harry, Eastland, Tex.
Alberston, M., Depew, Okla.
Allen, Walter, Tulsa, Okla.
Allison, A. P., Lincoln, Neb.
Ames, Edward W., Dallas, Tex.
Anderson, Carl B., Tulsa, Okla.
Anderson, G. E., Norman, Okla.
Applin, Paul L., Houston, Tex.
Applin, Mrs. Paul L., Houston, Tex.
Aurin, F. L., Ponca City, Okla.
Bailey, Thomas L., Austin, Tex.
Baker, R. F., Houston, Tex.
Baker, William A., Jr., Tampico, Mex.
Ball, Max W., Denver, Colo.
Ballard, A. L., San Antonio, Tex.
Barrow, L. T., Austin, Tex.
Barton, Donald C., Houston, Tex.
Becker, Clyde M., Chickasha, Okla.
Beekly, A. L., Tulsa, Okla.
Bell, H. W., Shreveport, La.
Bell, John, Tampico, Mex.
Benton, L. B., Houston, Tex.
Berger, Walter R., Dallas, Tex.
Bierman, Alfred C., Dallas, Tex.
Birk, R. A., Ardmore, Okla.
Blackburn, W. D., Houston, Tex.
Blanchard, J. B., San Antonio, Tex.
Bloesch, E. T., Tulsa, Okla.
Bostick, J. Wallace, Dallas, Tex.
Bowman, W. F., Houston, Tex.
Boyle, A. C., Jr., Laramie, Wyo.
Brace, Orval L., Camden, Ark.
Bradish, Ford, Breckenridge, Tex.
Branner, George C., Little Rock, Ark.
Brauchli, Rudolph, Tulsa, Okla.
Broman, I. J., Round Rock, Tex.
Brown, J. Earle, Oklahoma City, Okla.
Bruyere, Alan, Tampico, Mex.
Bullard, Fred M., Norman, Okla.
Burg, Robert S., Fort Worth, Tex.
Burress, W. M., Tonkawa, Okla.
Burton, George E., Ardmore, Okla.
Butcher, S. D., Ponca City, Okla.

Butters, Roy M., Laredo, Tex.
Buttram, Wm. A., Oklahoma City, Okla.
Bybee, H. P., Austin, Tex.
Campbell, Robert B., Chicago, Ill.
Cannon, R. L., Houston, Tex.
Carlton, Dave P., Houston, Tex.
Cash, T. C., Breckenridge, Tex.
Cashin, D'Arcy M., Houston, Tex.
Cave, H. S., Houston, Tex.
Cavins, O. A., Apt. 64 Bis, Mex., D.F.
Chapin, Theodore, Tampico, Mex.
Cheney, M. G., Graham, Tex.
Clark, Clifton W., Wichita Falls, Tex.
Clark, Frank R., Tulsa, Okla.
Clark, Howard, El Dorado, Kan.
Clowe, Charles E., Ardmore, Okla.
Coats, Charles M., Wichita, Kan.
Collingwood, D. M., Urbana, Ill.
Conkling, R. A., Oklahoma City, Okla.
Cook, Carroll E., Austin, Tex.
Cottingham, V. E., Ada, Okla.
Crider, A. F., Shreveport, La.
Davis, Ralph E., Pittsburgh, Pa.
Decker, C. E., Norman, Okla.
DeGolyer, E., New York City
Deussen, Alexander, Houston, Tex.
DeWolf, F. W., Dallas, Tex.
Donoghur, David, Houston, Tex.
Donovan, P. W., Minneapolis, Minn.
Dorchester, Charles M., Shreveport, La.
Doub, Charles O., Tulsa, Okla.
Dumble, E. T., Houston, Tex.
Eckert, F. E., Pittsburgh, Pa.
Edson, D. J., Corsicana, Tex.
Eichelberger, O. H., Lake Charles, La.
Ellisor, Alva C., Houston, Tex.
English, Walter A., Taft, Cal.
Evans, Noel, Ponca City, Okla.
Ferguson, John L., Cisco, Tex.
Floyd, F. W., Tulsa, Okla.
Foster, W. L., Tulsa, Okla.
Freedman, Louis H., New York City
Frost, Jack, Mexia, Tex.
Fuqua, H. B., Wichita Falls, Tex.
Gardner, James H., Tulsa, Okla.
Garrett, L. P., Houston, Tex.
Garrett, Robert E., Tulsa, Okla.
Garrett, S. G., Fort Worth, Tex.
Gaylord, E. J., San Francisco, Cal.
George, H. C., Ardmore, Okla.
Gester, S. H., San Francisco, Cal.
Geyer, L. Park, Ponca City, Okla.
Goodrich, Robert D., Dallas, Tex.
Gordon, Dugald, Dallas, Tex.
Gouin, Frank, Tulsa, Okla.
Gould, Charles N., Oklahoma City, Okla.
Greene, Frank C., Tulsa, Okla.
Griffith, C. Le Roy, Tampico, Mex.
Hagan, A. M., Pittsburgh, Pa.
Hamilton, W. R., Houston, Tex.
Hance, James H., Urbana, Ill.
Hanna, Dallas G., San Francisco, Cal.
Hares, C. J., Denver, Colo.
Harper, Oliver C., Sweetwater, Tex.
Hartman, Adolph E., Fort Worth, Tex.
Hay, L. C., Independence, Kan.
Heald, K. C., Washington, D.C.
Henley, A. S., Houston, Tex.
Henniger, Waldemar F., Houston, Tex.
Hennen, Roy V., Pittsburgh, Pa.
Henning, John L., Lake Charles, La.
Herald, Frank A., Tulsa, Okla.
Herald, John M., Tulsa, Okla.
Herold, Stanley C., Stanford, Cal.
Heroy, William B., White Plains, N.Y.
Hindes, E. P., Bartlesville, Okla.
Hintze, F. F., Denver, Colo.
Hoffman, M. G., Tulsa, Okla.
Holloman, Roy, Shreveport, La.
Holman, Eugene, Shreveport, La.
Honess, Charles W., Bartlesville, Okla.
Hopkins, Edwin B., New York City
Hopper, Walter E., Shreveport, La.
Howe, Henry V., Baton Rouge, La.
Howell, J. V., Ponca City, Okla.
Hoyle, Charles R., Baton Rouge, La.
Hubbard, Wm. Earle, Wichita Falls, Tex.
Hughes, C. Don, Duncan, Okla.
Hughes, Richard, Tulsa, Okla.
Hughes, Urban B., Dallas, Tex.
Hull, Joseph Poyer Deyo, Shreveport, La.
Hutchinson, F. M., Houston, Tex.
Hyde, Clarence E., Oklahoma City, Okla.
Imbt, Robert F., Mexia, Tex.
Jennings, Charles I., San Antonio, Tex.
Jensen, Joseph, Los Angeles, Cal.

Johnson, Roswell H., Pittsburgh, Pa.
Jones, Richard A., Laredo, Tex.
Judson, S. A., Dallas, Tex.
Justice, P. S., Beaumont, Tex.
Kendrick, Frank E., Houston, Tex.
Kennedy, Luther E., Tulsa, Okla.
Kesler, L. W., Winfield, Kan.
Kirby, Grady, San Antonio, Tex.
Kite, W. C., Oklahoma City, Okla.
Knapp, Arthur, Philadelphia, Pa.
Kniker, Hedwig T., Houston, Tex.
Knox, J. K., Houston, Tex.
Kolm, Robert N., Wichita Falls, Tex.
Krampert, E. W., Cheyenne, Wyo.
Kraus, Edgar, Enid, Okla.
Kroenlein, Geo. A., Tulsa, Okla.
Langworthy, A. A., Tulsa, Okla.
LaRue, James E., Houston, Tex.
Lee, Wallace, Dallas, Tex.
Leighton, Morris M., Urbana, Ill.
Ley, Henry A., Independence, Kan.
Lewis, J. Whitney, Tulsa, Okla.
Lloyd, E. Russell, Denver, Colo.
Longyear, Robt. D., Minneapolis, Minn.
Loomis, Harve, Ardmore, Okla.
Lovejoy, John M., Tulsa, Okla.
Lynn, Robert H., Holdenville, Okla.
Lyons, Richard T., Mexia, Tex.
McCluer, R. D., Corsicana, Tex.
McCrary, E. W., Tulsa, Okla.
MacDonald, Donald F., New York City
McDonald, Worth W., Shreveport, La.
McFarland, R. S., Tulsa, Okla.
McKee, H. Harper, New York City
McLaughlin, H. C., Dallas, Tex.
McLellan, H. J., Cisco, Tex.
McLeod, Angus, Shreveport, La.
McNeese, Charles H., Ponca City, Okla.
Masterson, Rebecca, Houston, Tex.
Matson, George C., Tulsa, Okla.
Maverick, Phillip, San Antonio, Tex.
Mendenhall, W. C., Washington, D.C.
Meredith, Carlton, Dallas, Tex.
Merritt, John W., Tulsa, Okla.
Miller, F. J., Shreveport, La.
Miller, Willard L., Oklahoma City, Okla.
Miser, H. D., Washington, D.C.
Moncrief, E. C., Ponca City, Okla.
Monnett, Victor E., Norman, Okla.
Moore, Raymond C., Lawrence, Kan.
Morris, A. F., Mexia, Tex.
Muelleried, Frederick R. J., Mexico City
Myers, Julian Q., Tulsa, Okla.
Nash, Howard F., Tampico, Mex.
Nelson, Wilbur, Nashville, Tenn.
Nickell, C. O., Wichita Falls, Tex.
Nisbet, John M., Bartlesville, Okla.
Nolte, William J., Shreveport, La.
North, Lloyd, Houston, Tex.
Obering, E. A., Tulsa, Okla.
Ohern, D. W., Oklahoma City, Okla.
Orynski, Leonard W., Colorado, Tex.
Overbeck, R. M., Long Beach, Cal.
Parsons, Frank, Greenville, Tex.
Peabody, H. W., Tulsa, Okla.
Pellekaan, D. W. Van Holt, Tulsa, Okla.
Pepperberg, Leon, Dallas, Tex.
Perini, V. C., Jr., Denver, Colo.
Perkins, Joseph M., Oklahoma City, Okla.
Perrine, Irving, Oklahoma City, Okla.
Pishel, Max A., Tulsa, Okla.
Plummer, Fred B., Houston, Tex.
Pogue, Joseph E., New York City
Porch, E. L., Jr., Houston, Tex.
Powers, Sidney, Tulsa, Okla.
Pratt, Wallace E., Houston, Tex.
Preece, Rae, Tulsa, Okla.
Rade, Henry S., Houston, Tex.
Randolph, Oscar E., College Station, Tex.
Reed, Lyman C., Houston, Tex.
Reed, Warren B., Morgan City, La.
Reeves, Frank W., Dallas, Tex.
Renaud, Charles L., Cisco, Tex.
Reynolds, Roy A., Eastland, Tex.
Rich, John L., Ottawa, Kan.
Riggs, R. J., Tulsa, Okla.
Roark, E. L., Ponca City, Okla.
Roberts, Morgan E., Tampico, Mex.
Robertson, P. A., Tampico, Mex.
Robinson, Heath M., Dallas, Tex.
Roop, Charles W., Bartlesville, Okla.
Roth, E. E., Pittsburgh, Pa.
Rothrock, H. E., Tulsa, Okla.
Row, Charles H., Dallas, Tex.
Russ, Leon F., Dallas, Tex.
Russell, Philip G., Holdenville, Okla.

Ryan, Reg. G., Ponca City, Okla.
Sands, J. M., Bartlesville, Okla.
Sawtelle, George, Houston, Tex.
Schneider, H. G., Shreveport, La.
Schoolfield, R. F., Shreveport, La.
Schuchert, Charles, New Haven, Conn.
Scudder, E. W., Winfield, Kan.
Sealey, F. C., Houston, Tex.
Selig, R. L., Shreveport, La.
Sellards, E. H., Austin, Tex.
Semmes, D. R., Tampico, Mex.
Shaw, E. S., Denver, Colo.
Shayes, Fred P., Camden, Ark.
Sheldon, Israel R., Wichita Falls, Tex.
Shutt, Roscoe E., San Antonio, Tex.
Sickler, Jack M., Los Angeles, Cal.
Simonds, F. W., Austin, Tex.
Snider, L. B., Tulsa, Okla.
Snow, D. R., Tulsa, Okla.
Snyder, J. Y., Shreveport, La.
Sprague, William B., Houston, Tex.
Stacy, D. M., Oklahoma City, Okla.
Stander, Arthur E., Tulsa, Okla.
Stathers, Silas C., Shreveport, La.
Steinmayer, R. A., New Orleans, La.
Stephenson, Eugene A., Pittsburgh, Pa.
Stoner, Reginald C., Mexico, D.F.
Storm, W. Willis, Ardmore, Okla.
Stroud, Ben K., Los Angeles, Cal.
Studt, Charles W., Yates Center, Kan.
Suman, John R., Houston, Tex.
Tarr, Russell S., Tulsa, Okla.
Tatum, J. L., Tulsa, Okla.
Taylor, Chas. H., Oklahoma City, Okla.
Teas, L. P., Shreveport, La.
Thom, W. T., Jr., Washington, D.C.
Thomas, C. R., Tulsa, Okla.
Thomas, J. Elmer, Chicago, Ill.
Thompson, J. D., Jr., Amarillo, Tex.
Thompson, R. R., Thurber, Tex.
Thompson, S. A., Houston, Tex.
Thompson, Wallace C., Sun Oil Company, Dallas, Tex.
Tomlinson, C. W., Ardmore, Okla.
Trager, Earl R., Ponca City, Okla.
Trout, L. E., Oklahoma City, Okla.
Truex, A. F., Tulsa, Okla.
Tygrett, H. V., Dallas, Tex.
Udden, J. A., Austin, Tex.
Vaughan, F. E., Houston, Tex.
Wagener, Charles H., Dallas, Tex.
Waring, G. A., Tulsa, Okla.
Warner, C. A., Okmulgee, Okla.
Wasson, T., Columbus, Ohio
Wegemann, Carroll H., Denver, Colo.
Weinzierl, John F., Ponca City, Okla.
White, David, Washington, D.C.
White, I. C., Morgantown, W.Va.
White, Luther H., Tulsa, Okla.
Whitehead, R. B., Dallas, Tex.
Whitney, F. L., Austin, Tex.
Whittier, W. H., Greenville, Tex.
Wilson, John H., Denver, Colo.
Wilson, W. B., Tulsa, Okla.
Winton, W. M., Fort Worth, Tex.
Wohlford, Charles J., Houston, Tex.
Woolsey, E. V., Dallas, Tex.
Wrather, W. E., Dallas, Tex.
Wright, A. C., Shreveport, La.
Yoakum, C. A., Holdenville, Okla.

More than 200 registered visitors were also present.

RAYMOND C. MOORE

PROGRAM OF NINTH ANNUAL MEETING AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

HOUSTON, TEXAS, MARCH 27, 28, 29, 1924

Headquarters—Rice Hotel

THURSDAY MORNING SESSION

ADDRESSES OF WELCOME:

On behalf of city of Houston: HON. OSCAR F. HOLCOMBE, mayor.

On behalf of Houston Geological Society: JOHN R. SUMAN, president Houston Geological Society.

RESPONSE:

MAX W. BALL, president American Association of Petroleum Geologists.

TECHNICAL SESSION

1. The Luling Oil Field, Caldwell County, Texas, by E. H. SELLARDS.
2. South Bosque Oil Field, McLennan County, Texas, by DILWORTH S. HAGER AND R. O. BROWN. (By title.)
3. The Chapeno Salt Dome, Tamps., Mexico, by BEN C. BELT. (By title.)
4. Salt Domes in Northern Louisiana, by W. C. SPOONER. (By title.)
5. The Extension of a Portion of the Pontotoc Series around the West End of the Arbuckle Mountains, by R. A. BIRK.
6. A Buried Hill East of Ardmore, Oklahoma, by C. W. TOMLINSON. (By title.)
7. Geological Department Methods and Administration, by J. A. TAFF AND E. G. GAYLORD.
8. Logging Wells Drilled by the Rotary Method, by EDGAR KRAUS. (By title.)
9. The Upthrust of the German Salt Masses, by HANS STILLE. (Introduced by D. C. BARTON.) (By title.)
10. New Areal Geologic Map of Oklahoma, by WALTER C. MENDENHALL.
11. Application of Dynamics to Oil Field Finding in Southern California, by R. N. FERGUSON AND C. G. Willis.
12. Interior Salt Domes of Northeast Texas, by SIDNEY POWERS. (By title.)
13. The Batson, Texas, Oil Field, by W. F. HENNIGER. (By title.)
14. Need of a Geological Museum in the Southwest, by J. A. UDDEN.

PRELIMINARY BUSINESS MEETING, INCLUDING ELECTION OF OFFICERS FOR 1924–25

THURSDAY AFTERNOON SESSION

15. The Subsurface Stratigraphy of the Coastal Plain of Texas and Louisiana, by MRS. PAUL APPLIN, MISS ALVA ELLISOR AND MISS HEDWIG KNIKER.
16. The Use of Foraminifera in Geologic Correlation, by J. A. CUSHMAN.

17. The Values of Minute and Large Fossils in Subsurface Stratigraphy, by CHARLES SCHUCHERT.
18. Correlation of Organic Shales in the Southern End of the San Joaquin Valley, California, by E. G. GAYLORD AND G. DALLAS HANNA. (Lantern slides.)
19. The Orange, Texas, Oil Field, by ALEXANDER DEUSSEN. (By title.)
20. Some Characteristics of the Comanchean Formations at Mexia as Shown by Well Cuttings, by JACK FROST. (Introduced by R. B. WHITEHEAD.) (By title.)
21. The Theory of Control and Its Application to Well Production, by STANLEY C. HEROLD.
22. Geological Section in the Lower Rio Grande Valley, Texas, as Determined by the Study of Samples from the Santo Domingo Well, by THOMAS L. BAILEY. (Introduced by J. A. UDDEN.) (By title.)
23. Bryan Heights Salt Dome, Brazoria County, Texas, by WILLIAM KENNEDY. (By title.)
24. The Powell Oil Field of Texas, by R. D. MCCLUER AND W. C. MCGLOTHLIN.
25. Subsurface Observations in Southeastern Kansas, by HENRY A. LEY.
26. Minerva Field, Milam County, Texas, by DILWORTH S. HAGER AND R. O. BROWN. (By title.)
27. A Study of the Thermal-Decomposition of Oil Shale Kerogen, by MARTIN J. GAVIN. (Introduced by MAX W. BALL.)
28. The Anse La Butte Oil Field, Louisiana, by D'ARCY M. CASHIN. (By title.)
29. The New Iberia, Louisiana, Salt Dome, by E. W. BRUCKS. (By title.)
30. The Sulphur, Louisiana, Salt Dome, by P. K. KELLY. (Introduced by W. E. PRATT.) (By title.)
31. The Vinton, Louisiana, Salt Dome, by S. A. THOMPSON. (By title.)
32. The Big Hill Salt Dome, Jefferson County, Texas, by A. S. HENLEY. (By title.)
33. The Burbank Oil Field of Osage County, Oklahoma, by J. M. SANDS.
34. A Study of the Application of Oil Field Water Analyses to the Fault Zone Type of Accumulation, by R. B. WHITEHEAD AND R. H. FASH.
35. Economic Results of Core Drilling in California Oil Fields, by R. P. MCLAUGHLIN.
36. The Relationship between the Open Flow Gauge and the Working Capacity of Gas Wells, by E. A. STEPHENSON.

FRIDAY MORNING SESSION

SALT DOME SESSION

37. The West Columbia Oil Field, Brazoria County, Texas, by DAVE P. CARLTON.
38. The Hull Oil Field, Liberty County, Texas, by W. D. BLACKBURN. (By title.)

39. The Edgerly, Louisiana, Oil Field, by H. E. Minor. (By title.)
40. The Welsh Oil Field, Jeff Davis Parish, Louisiana, by LYMAN C. REED. (Introduced by JOHN R. SUMAN.) (By title.)
41. The North Dayton Salt Dome, Liberty County, Texas, by T. R. BANKS. (By title.)
42. The Salt Domes of South Texas, Falfurrias, Palangana, Piedras Pintas, Sal del Rey and La Sal Vieja, by DONALD C. BARTON.
43. The Goose Creek Oil Field, Harris County, Texas, by H. E. MINOR. (By title.)
44. The Barbers Hill Salt Dome, Chambers County, Texas, by GEORGE M. BEVIER. (By title.)
45. The Stratton Ridge Salt Dome, Brazoria County, Texas, by PAUL L. APPLIN. (By title.)
46. Big Hill Salt Dome, Matagorda County, Texas, by ALBERT G. WOLF. (Introduced by ALEXANDER DEUSSEN.)
47. Preliminary Report on the Petrography of Salt Dome Caprock, by MARCUS I. GOLDMAN. (Lantern slides.)
48. A Study of the Gulf Coast Production Curves of the Oil and Gas Manual with Reference to Maximum and Minimum Production, by R. C. TUCKER. (Read by Dr. I. C. WHITE.)
49. The Distribution, Classification, and Alignment of Gulf Coast Salt Domes, by ALEXANDER DEUSSEN.
50. Oil from Unclosed Structures in Oklahoma, by LUTHER WHITE.
51. The Theory of Water Drive Oil Production, by ROSWELL H. JOHNSON, O. H. BLACKWOOD, AND FOREST DORN.
52. The Davis Hill Salt Dome, Liberty County, Texas, by WALLACE E. PRATT. (By title.)
53. Hoskin's Mound Salt Dome, Brazoria County, Texas, by JOHN R. SUMAN. (By title.)
54. The High Island Salt Dome, Galveston County, Texas, by ROBERT W. PACK. (By title.)

FRIDAY AFTERNOON

Field trip to Barbers Hill and Goose Creek.

FRIDAY EVENING

Annual Banquet, Ballroom, Mezzanine Floor, Rice Hotel.

SATURDAY MORNING SESSION

SALT DOME SESSION

55. Sections Showing Structure of Northwest European Salt Domes as Revealed in Salt Mines, by W. A. J. M. VAN WATERSCHOOT VAN DER GRACHT.
56. The Origin of Salt Domes, by E. DEGOLYER.
57. The Spindletop Salt Dome and Oil Field, Jefferson County, Texas, by DONALD C. BARTON AND R. B. PAXSON. (By title.)

58. Interpretation of Rotary Drill Samples, by PAUL WEAVER. (By title.)
59. The Jennings Salt Dome and Oil Field, Acadia Parish, Louisiana, by DONALD C. BARTON AND R. H. GOODRICH. (By title.)
60. The Pine Prairie Salt Dome, Evangeline Parish, Louisiana, by DONALD C. BARTON. (By title.)
61. The Five Islands, Louisiana, Avery, Jefferson, Weeks, Cote Blanche and Belle Isle, by F. E. VAUGHAN. (By title.)
62. The Hockley Salt Dome, Harris County, Texas, by ALEXANDER DEUSSEN AND LAURA LEE LANE. (By title.)
63. The South Dayton Salt Dome, Liberty County, Texas, by W. F. Bowman. (By title.)
64. The Damon Mound Salt Dome, Brazoria County, Texas, by GEORGE M. BEVIER. (By title.)
65. The Blue Ridge, Texas, Oil Field, by DILWORTH S. HAGER. (By title.)

BUSINESS SESSION

SATURDAY AFTERNOON SESSION

TECHNICAL SESSION

66. The Big Creek Salt Dome, Fort Bend County, Texas, by LOUIS H. FREEDMAN. (By title.)
67. The Section 28 Salt Dome, St. Martin's Parish, Louisiana, by DAVID DONOGHUE. (By title.)
68. The Hackberry Island Salt Dome, Cameron Parish, Louisiana, by W. F. HENNIGER. (By title.)
69. The Bayou Bouillon Salt Dome, St. Martin's Parish, Louisiana, by DAVID DONOGHUE. (By title.)
70. The Sour Lake Oil Field, Hardin County, Texas, by R. F. BAKER. (By title.)
71. The Markham Oil Field, Matagorda County, Texas, by F. C. SEALEY. (By title.)
72. The Salt Dome at Boling, Wharton County, Texas, by W. F. HENNIGER. (By title.)
73. The Pierce Junction Oil Field, Harris County, Texas, by DAVID DONOGHUE. (By title.)
74. The Saratoga Oil Field, Hardin County, Texas, by JOHN R. SUMAN. (By title.)
75. The Humble Oil Field, Harris County, Texas, by R. F. BAKER. (By title.)
76. The Graham Field, Oklahoma, by WILLIS STORM AND C. W. TOMLINSON.
77. Subsurface Conditions in the Okemah-Wewoka District, by L. E. KENNEDY AND RAY PREECE.
78. Experiments on the Wear of Sand Grains, by G. E. ANDERSON. (Introduced by C. E. DECKER.)

79. Oil Possibilities of Parts of South Dakota, by C. T. Lupton and E. M. Parks. (By title.)
80. An Experimental Study of Faulting, by Paul Torrey and Ionel Gradescu. (Introduced by R. H. Johnson.)
81. The Origin of the Green River Formation, by Junius Henderson. (Introduced by Max W. Ball.)
82. A Microscopic Study of the Interrelationship of Oil, Gas, and Water, by Roswell H. Johnson and Milbert Schwarz.
83. Notes on the Origin of Petroleum, by F. W. Van Tuyl.
84. The Probable Oil Resources of British India, by J. K. Knox. (By title.)
85. Criteria for the Recognition of Heavy Minerals in the Simpson Formation, by Mrs. Fanny C. Edson. (By title.)
86. The Rock Salt Masses in the Rumanian Carpathian Region Considered from a Geological Point of View, by Prof. Dr. J. P. Voitesti. (Introduced by Sidney Powers.) (By title.)
87. Volcanic Rocks in the Cretaceous of Louisiana, by M. N. Bramlette. (By title.)
88. Paleogeography of the Mid-Continent Area during the Carboniferous Age as Indicated by the Sediments and Structural Conditions of North Central Texas, by M. G. Cheney. (By title.)
89. Rumanian Oil Fields, by F. L. Mason. (By title.)
90. Notes on Natural Gas Fields of Transylvania, Rumania, by Frederick G. Clapp. (By title.)
91. A New Classification of the Permian Red Beds of Southern Oklahoma, by Charles N. Gould. (By title.)

Sunday, March 30

Field trip to Texas-Gulf Company's Sulphur Mine, Gulf, Matagorda County, Texas.

Monday, March 31

Field trip to New Iberia, Louisiana: Avery Island Salt Mine, Jefferson Island, and New Iberia Domes.

Wednesday, April 2

PALESTINE TRIP

Palestine and Keechi Salt Domes and Palestine Salt Works, Mr. Sidney Powers, leader.

Local Committees in Charge of the Meeting

GENERAL CHAIRMAN, ALEXANDER DEUSSEN

Program.—Wallace E. Pratt, chairman; R. F. Baker, D. C. Barton, G. M. Bevier, E. T. Dumble, Dilworth Hager, H. E. Minor, R. W. Pack, F. B. Plummer.

Arrangements.—D. C. Barton, chairman; F. B. Plummer, G. M. Bevier, E. W. Brucks, Charles Jaqua, Lyman Reed.

Hotels.—David Donoghue, chairman; W. D. Blackburn, W. F. Bowman, Edgar Kraus.

Reception.—Dilworth Hager, chairman; Mrs. Paul Applin, Miss Alva Ellisor, Miss Hedwig Kniker, Miss Laura Lee Lane, Miss Reba Masterson, Mrs. F. B. Plummer, Miss Elizabeth Stiles, Paul Applin, O. H. Eickelberger, Fred C. Sealy, D. M. Cashin, W. F. Bowman, V. C. Perini, Grady Kirby, F. E. Vaughan, George Sawtelle, L. B. Benton, T. M. Prettyman, E. G. Thompson, J. B. Blanchard.

Banquet.—D. M. Cashin, chairman; A. S. Henley, Paul Leavenworth, Lloyd North, S. A. Thompson, Miss Grace Newman, Mrs. F. B. Plummer.

Field trips.—W. F. Henniger, chairman; R. F. Baker, D. P. Carlton, H. E. Minor, F. B. Plummer, Fred C. Sealy, D. C. Barton.

Ladies.—S. A. Thompson, chairman.

Finance.—L. P. Garrett, chairman; F. M. Hutchinson, H. E. Minor D. M. Cashin.

Automobiles.—D. C. Carlton, chairman; T. R. Banks.

Publicity.—D. C. Barton, chairman; B. M. Bevier, R. L. Dudley.

Entertainment.—J. Elmer Thomas, chairman; George Sawtelle, R. L. Dudley, R. B. Whitehead, Luther White, Ben Stroud, J. Earle Brown.

Committee for Ladies' Entertainment.—*At Large:* Mrs. L. P. Garrett, Mrs. Wallace E. Pratt, Mrs. John R. Suman. *Registration:* Mrs. Dave Carlton, Miss Elizabeth Stiles, Miss Emma Jane Coffman. *Bridge Tea:* Mrs. D. C. Barton, Mrs. David Donoghue, Mrs. J. O. Bryant, Mrs. A. S. Henley, Mrs. R. H. Goodrich, Mrs. H. E. Minor, Mrs. W. D. Blackburn. *Luncheon San Jacinto Inn:* Mrs. W. F. Henniger, Mrs. F. O. Sealy, Mrs. John Knox, Mrs. R. F. Baker, Mrs. F. E. Vaughan, Mrs. Geo. Sawtelle. *Reception at Hotels:* Mrs. G. M. Bevier, Mrs. Dave Carlton, Mrs. R. L. Dudley, Mrs. R. P. Paxson, Mrs. W. F. Bowman, Miss Elizabeth Stiles, Miss Emma Coffman.

BUSINESS MEETING OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS, HOUSTON, TEXAS, MARCH 27, 1924, MAX W. BALL, PRESIDING

Report of the President

My predecessor last year established the precedent, in my opinion a very wise one, of submitting a president's report to the Association, setting out the more important things affecting the Association's welfare during his term, and suggesting further actions or policies for the Association's welfare in the future. Following his example, I submit the following report:

The principal steps taken by the executive committee during the year were:

1. The appointment of regional directors
2. The appointment of a research committee
3. The taking of steps toward the incorporation of the Association
4. The final adoption of the code of ethics
5. The adoption of a definite plan for the investment of Association funds
6. The election to honorary membership of Dr. Hofer, of Austria
7. The following of last year's precedent in the holding of a mid-year meeting

1. At last year's meeting there was evident a desire on the part of some sections of the country for a closer contact with the administration of the Association. To meet this desire, and to help in the increased affairs of the Association, five regional directors, one each for the East, the Mid-Continent, the Gulf Coast, the Rocky Mountains, and the Pacific Coast, were appointed. They have proved a very real help to the executive committee, doing much of the work of the Association in their respective territories, and adding strength and efficiency to the administrative organization. The plan has proved so definitely useful and workable that its continuance seems assured.

2. A research committee, with W. E. Wrather as chairman, was appointed, and has done much work during the year in studying the field and gathering suggestions as to problems. Work of this type must be done on a long-term basis, and we hope that the present research committee will be continued indefinitely by succeeding executive committees.

3. The Association is not now incorporated. It exists as an amorphous unincorporated aggregation of individuals. We have consulted counsel and have been advised that incorporation would give the Association a more definite status, would make its contracts binding on the Association rather than on the officers who sign them, would lessen the personal liabilities of the officers to outsiders without lessening their liabilities to the Association, and would give it a permanency and self-perpetuating character which it does not now have.

Mr. James R. Jones, attorney-at-law of Cheyenne, Wyoming, has very kindly, without cost to us, studied the various statutes involved, and has prepared a draft of articles of incorporation which we hope to file. Two steps are necessary: The Association must by vote authorize the executive committee to proceed to incorporate the Association, and each member of the Association must consent in writing to the transfer of his membership from the unincorporated to the incorporated Association. Both of these will be presented subsequently for your consideration.

4. Most of you remember that about two years ago the membership, by an overwhelming vote, indorsed the idea of a detailed code of ethics. The draft of that data has been carefully condensed and clarified, and has now been adopted by the executive committee.

5. During the year the greater part of the Association's funds have been taken out of savings banks and open accounts and put into sound invest-

ments. About $4,000 is in government treasury certificates, about $2,000 in first mortgages, and about $6,000 in bonds rated as "A" or better by Moody. The executive committee adopted the following resolution:

Be It Resolved, That the present executive committee hereby adopts and recommends to its successors that they use the following plan as to the classes and character of investments for the Association's surplus funds; and that the secretary be and he is hereby instructed to invest, in accordance with this plan, all of the Association's funds not needed for current running expenses:

	Per Cent
Bonds of power companies, preferably hydro-electric companies	40
Bonds of other corporations	30
Municipal bonds	20
Corporation short-time notes	10

All corporation investments, whether in bonds or notes, to be confined to the securities of corporations given an A rating by the Moody Investors' Service or an equivalent rating by an equally responsible rating service; municipal bonds to include the obligations of states, counties, cities, towns, school districts in suitable cities and towns, but not irrigation or drainage districts; no bonds to be purchased in a municipal or road district with a population of less than 1,000, or in a school district with a population of less than 300 people; and no investment to be made in districts where most of the revenue comes from the mineral industries; not more than $2,000 of the Association's funds to be invested in the bonds of any one corporation or municipal subdivision.

6. Under the constitutional amendment which became effective during the year the executive committee has elected to honorary membership Dr. H. von Hoefer, of Vienna, the author of "Das Erdöl." and the dean of European petroleum scientists.

7. There is no need to describe the mid-year meeting held at Los Angeles in September. Those who were there are still talking about it. These mid-year meetings widen the influence of the Association among oil men, bring the Association in contact with many geologists not otherwise accessible, lessen the dangers of sectional feeling inside the Association, and stimulate the flow of excellent material to the *Bulletin*. Though it may not be wise to hold one every year, the general idea of the mid-year meeting seems to have come to stay.

These are the chief tangible facts of the year. The more important facts lie in a continued spirit of fellowship, of enthusiastic service, of interest in the Association and its affairs, and of readiness to tackle any amount of work if the Association asks it.

I want, personally, to thank the members of the executive committee, each and every one, for loyalty, friendship, and unremitting co-operation; the regional directors for work and willingness despite the newness of the position and the suddenness of their appointments; the committees in California and in Houston who have made this meeting and the California meeting possible; the many

men who have helped and advised in special ways; and the widespread membership, who, by their confident support of the Association, make its success and that of its president possible.

Surely no finer group of men could be gotten together than the 1,100 men of the American Association. I have never enjoyed a job more than my year as president.

Respectfully submitted,

MAX W. BALL

REPORT OF THE SECRETARY

Vote on constitutional changes resubmitted following the meeting in March, 1923;

1. To increase requirement for associate members from twenty to thirty hours:
   For increase, 445; against increase, 64; majority for, 381
2. To establish honorary membership:
   For, 420; against, 89; majority for, 331
3. To empower editor to appoint associate editors:
   For, 450; against, 59; majority for, 391
4. Constitution amended by more than one-half of active membership:
   For, 394; against, 115; majority for, 279

Members eligible to vote	678
Votes cast	509
Votes necessary to validate election	494

Accordingly all four propositions carried.

Membership of the Association:

Number of members March 15, 1919	210	
Number of members March 20, 1923	901	
Number of active members March 22, 1924	840	
Number of associate members March 22, 1924	240	
Total number of members March 22, 1924		1,080
Applicants elected, dues unpaid	37	
Applicants published, not notified of election	24	
Applicants approved for publication	47	
Recent applications	30	
Total number of applications		138
Number of members withdrawn	4	
Number of members dropped	20	
Number of members died	2	
Number of members in arrears, 1922 dues	11	
Number of members in arrears, 1923 dues	28	
Active members in arrears, 1924 dues	213	
Associate members in arrears, 1924 dues	70	
Total members in arrears, 1924 dues		283

Distribution of Publications:

1. Subscriptions:		
Libraries (Domestic, 70) (Foreign, 4)	74	
Companies (Domestic, 26) (Foreign, 13)	39	
Individuals (Domestic, 46) (Foreign, 10)	56	
Total subscriptions		169
Exchanges, etc.	10	

2. Sale of Current and Back Numbers:
Receipts from sale at secretary's office exceeds receipts from subscriptions by $648.

Respectfully submitted,

CHARLES E. DECKER, *Secretary*

REPORT OF THE TREASURER: STATEMENT OF RECEIPTS AND DISBURSEMENTS MARCH 26, 1923, TO MARCH 20, 1924

RECEIPTS

Annual Dues:				
Associate dues		$1,598.00		
Active dues		8,401.00	$9,999.00	
Receipts from Sale of Bulletin:				
Current bulletins		$1,544.47		
Back numbers		2,239.69		
Bound copies, Vol. VII		330.10	4,114.26	
Miscellaneous Receipts:				
Advertising		$1,253.14		
Interest		356.00		
Separates		10.00		
Sundries		26.12	1,645.26	
Open account, per bank, March 26, 1923	$5,895.83			
Less checks out	81.38	$5,814.45		
Savings account		6,638.67	12,453.12	
Total receipts				$28,211.64
Collections not applied				.35
Grand total				$28,211.99

DISBURSEMENTS

Expense of Publication:			
Editor's Office:			
Editor's salary..................	$ 600.00		
Supplies and postage............	67.67		
Telegrams.....................	19.53		
Packing bulletins................	17.93		
Article translated................	15.00	$ 720.13	
Advertising Manager's Office:			
Commissioned sales.............	$66.97		
Postage........................	16.00		
Stationery......................	8.65	91.62	
Editorial Secretary's Office:			
Secretary's salary...............	$ 618.00		
Supplies........................	63.05		
Postage........................	24.95	706.00	
University of Chicago Press:			
Printing Bulletins:			
Vol. VII, No. 1...............	$790.44		
Vol. VII, No. 2...............	811.63		
Vol. VII, No. 3...............	766.84		
Vol. VII, No. 4...............	922.38		
Vol. VII, No. 5...............	869.87		
Vol. VII, No. 6...............	892.72	5,053.88	
Printing separates and index......	$630.88		
Corrections and mailing..........	345.74		
Binding VII, No. 1..............	26.50	1,003.12	$7,574.75
Expense of General Office:			
Secretary-treasurer's salary.........	$ 900.00		
Stenographer.....................	588.90		
Extra clerical help................	29.75		
Printing........................	315.59		
Postage........................	216.56		
Express and drayage..............	61.96		
Exchange and refunds............	25.35		
Supplies........................	13.92		
Protested check..................	6.00		
Miscellaneous....................	43.40		2,201.43
Carried forward..................			$9,776.18

DISBURSEMENTS—*Continued*

Brought forward			$9,776.18
Expense of Meetings:			
Shreveport:			
Secretary's and Stenographer's expenses	$ 128.28		
Printing, postage, and supplies	35.58		
Clerical help	25.00		
Telegrams	8.77		
Picture for editor	2.50	$ 200.13	
California:			
Secretary's expenses	$ 159.28		
Postage, printing, and supplies	135.30		
Telegrams	2.65	297.23	497.36
Investments:			
Treasury certificates	$4,100.00		
Wyoming farm loans	2,000.00		
International Trust Co. of Denver	5,259.56		
International Trust Co. of Denver	1,018.50		
Accrued interest on farm loans	37.10		12,415.16
Total disbursements			$22,688.70
Open account, per bank, March 20, 1924		$1,066.74	
Less checks out		340.12	
		$ 726.62	
Savings account		4,796.67	
Total on hand			5,523.29
Total			$28,211.99

Summary of Resources for Six Years:

1919	$ 83.54
1920	926.89
1921	3,582.76
1922	7,291.15
1923	12,453.12
1924	17,938.45

Respectfully submitted,

CHARLES E. DECKER, *Treasurer*

Report of the Editor

The report of the editor can be briefly given. I have previously said that the editor makes a number of reports during the year; for each number of the *Bulletin* is his report.

The end of 1923 marks the close of the first year of publication by the University of Chicago Press. The character of the *Bulletin* is, I believe, a decided improvement, and marks a policy in publication which I think should be continued.

Probably the outstanding feature of the year's work is the consolidation of the work of the editor through the associate editors. This assistance, and the procedure through which each paper now passes, insures, with the aid of the work in Chicago, a much more careful handling, mechanical and supervisory, than was possible previously. This is reflected in the *Bulletin*, and is obvious to all. A number of minor features have been developed, into which I need not go. The work of the advertising has been carried through the year by Mr. J. Elmer Thomas.

I should like to mention the effective work of Mr. K. C. Heald as acting editor-in-chief during a portion of the past year when I was absent from the office on a geological adventure in the Grand Canyon.

A considerable number of members have ordered the bound copies of Volume VII in addition to the copies separately received during the year. Those who have not ordered these may do so during the year, but it is necessary for you to order it in advance. The price is $2.00. We have on hand material for forthcoming publications, and there seems to be a great deal of material in connection with this meeting.

Respectfully submitted,

Raymond C. Moore, *Editor*

New Business

On motion of Mr. Deussen, the incorporation of the Association was referred to the general committee.

Election of Officers

James H. Gardner was the only nominee for president, and he was elected unanimously. Mr. Gardner responded to a request for a speech as follows:

"I hope that your confidence in me may not prove unfounded. This may be my last opportunity to hold before you in some degree the ideals and the duties which we have before us in the coming year. The Association has come to the point where we have been recognized as educational and scientific, as well as economic, in standing throughout the world. Our members are working all over the world, and our publications are finding their way to libraries and foreign institutions. It will be necessary that we tackle some research problems and work them out thoroughly. Therefore, I should like to hold before you the slogan of 'Research' for 1924–25. Research consists in classification, observa-

tion, experiment, and reason. We have perhaps tried to do too much through reason alone. In the last two or three years there has been a paucity of papers on purely theoretical matters. We must get at the problem in a bigger and broader way.

"We must get our resourcefulness and ingenuity together. There is a feeling that we should get behind some particular line and push it through. Whatever we decide to do, let us get behind it in a spirit of co-operation and good fellowship. The chief asset of our Association is the building up of a true genuine feeling of friendliness."

E. G. Gaylord was unanimously elected vice-president; Charles E. Decker was unanimously re-elected secretary-treasurer; and Raymond C. Moore was unanimously re-elected editor.

These four, together with Max W. Ball, the retiring president, constitute the executive committee.

Report of the Resolutions Committee

"During the present meeting of the American Association of Petroleum Geologists, the Mayor, the Chamber of Commerce, the people, and the press of Houston, and the management of the Rice Hotel, have contributed largely and freely to the success of the program and entertainment of those attending, and the Association desires heartily to extend its appreciation.

"Especial thanks are due to the following companies and individuals: Atlantic Oil Producing Company, Carter-Kelly Lumber Company, Gulf Production Company, Mr. Harry C. Hanszen, Higgins Oil and Fuel Company, Mr. Will C. Hogg, Houston Oil Company of Texas, Hughes Tool Company, Humble Oil and Refining Company, Kirby Petroleum Company, Mr. T. P. Lee, J. H. McEvoy & Company, Rio Bravo Oil Company, Roxana Petroleum Corporation, Rycade Petroleum Corporation, Mr. P. J. Scranton, Mr. Travis L. Smith, Mr. H. T. Statti, Southern Exploration Company, The Texas Company, and also to companies and individuals at Barbers Hill, Gulf, New Iberia, Palestine, and Damon Mound, through whose courtesy the success of the field trips has been assured.

"Especial thanks are also due to the officers and members of the Houston Geological Society, and all members of the local committees, for the amount of energy and effort so cheerfully given by them to make the Houston meeting the most successful ever held.

"The Association also wishes to express its appreciation to the local ladies' entertainment committees for the unusually effective and particularly pleasing entertainment of the visiting ladies.

E. Russell Lloyd
E. B. Hopkins

A rising vote of thanks was given for the work of Messrs. Donoghue, Deussen, and Pratt, and others on the local committees.

REPORT OF THE GENERAL COMMITTEE

"WHEREAS, The American Association of Petroleum Geologists has already indorsed at a previous meeting the necessity of completing the topographic mapping of the United States; be it therefore

"*Resolved*, That we indorse the provisions of the Temple Bill now before Congress, which calls for the completion of a topographic map of the United States within twenty years, and that we request that Congress hold public hearing on this bill as soon as possible."

This resolution was adopted on motion.

Mr. Donoghue presented to the Association the matter of incorporating the Association. A motion was made and carried that those who have this matter in hand be instructed to proceed. Mr. Ball requested that all members sign cards consenting to transfer of membership to an incorporated body.

A recommendation from the National Research Council was brought before the meeting in regard to the teaching of microscopic paleontology and the study of sedimentary petrography. A resolution was adopted that the American Association of Petroleum Geologists urge the study of microscopic paleontology and sedimentary petrography in the colleges and universities of the United States that give advanced instruction in geology, and that members of the Association support such studies by furnishing material for study and experimental work in so far as possible.

The three following resolutions were also adopted:

That the American Association of Petroleum Geologists considers systematic training in petroleum engineering highly desirable and recommends that more and better facilities for such training be provided, particularly in those states that produce oil commercially.

That the American Association of Petroleum Geologists authorizes the appointment by the executive committee of a local committee in Tulsa, Oklahoma, to prepare, under the auspices of the Association, an exhibit for the International Petroleum Exposition, and requests the co-operation of the members in furnishing suitable material.

That WHEREAS, The National Research Council is promoting a project for the establishment and maintenance of an *Abstract Journal of Geology;* and that

WHEREAS, Such an abstract journal would greatly facilitate and tend to advance research in geology and would effect a large economy in the labors of geologists engaged in research; and that

WHEREAS, The American Association of Petroleum Geologists is deeply interested in geological research and in the economy of effort in such research; therefore be it

Resolved, That the American Association of Petroleum Geologists cordially indorses the proposal to establish an *Abstract Journal of Geology*, pledges its support to the project, and urges its members individually to contribute financially as liberally as possible.

The general committee recommended that the executive committee consider the possibilities of holding a mid-year meeting in the East, preferably at Washington or New York. It was the opinion that the meetings at Denver and Los Angeles strengthened the Association to such an extent that a similar meeting in the East would stimulate more interest.

Mr. DeGolyer, on behalf of the members in New York City, invited the Association to hold a meeting in that city, and this invitation was referred to the executive committee.

W. E. Pratt, *Chairman*	Harve Loomis
David Donoghue, *Secretary*	E. Closuit
E. G. Gaylord	W. E. Hubbard
G. C. Gester	E. Holman
E. F. Hintze	W. B. Heroy
A. L. Beekly	Geo. Sawtelle
R. S. McFarland	S. A. Thompson
Leon J. Pepperberg	Wilbur Nelson

General Committee

MEETING OF EXECUTIVE COMMITTEE, HOUSTON, TEXAS, MARCH 26, 1924, MAX W. BALL, PRESIDING

The members present were Messrs. Ball, Moore, DeWolf, and Decker.

It was moved, seconded, and carried that $300.00 be allowed the editor's office for secretarial work during the past year, check to be sent to the Treasurer, University of Kansas.

A bill presented by Mr. Ball for $72.31 for telegrams and postage was allowed. A motion was carried that this be paid by the Association, the check to be sent to the Marine Oil Company, Denver, Colorado.

A motion was made and carried that the resignation of Mr. J. Elmer Thomas as advertising manager be accepted, with expression of appreciation of the excellent work done by him, and with regrets that he feels it necessary to resign.

A motion was made and carried that the committee approve the articles of incorporation presented by Mr. Ball, and recommend that the Association vote to incorporate the Association.

A motion was made and carried that Dr. Hofer be elected to honorary membership in the Association.

A motion was made and carried that the editor be authorized to appoint, for a designated time, a correspondent in various foreign countries to whom the *Bulletin* shall be supplied gratis whenever it seems advisable.

The code of ethics was discussed at length and much time was spent in revising a revision by Mr. Ball of a draft proposed by Mr. Deussen. The committee at length adopted the following motion:

WHEREAS, The executive committee is charged by the constitution with the suspension or expulsion of members for flagrant violation of the established principles of professional ethics; and

WHEREAS, The membership of the Association, by a large vote, had declared in favor of the formulation of the established principles of professional ethics into a code;

Now, therefore, The executive committee hereby adopts the following code of ethics, to which the object of the Association is prefixed.

OBJECT

The object of this Association is to promote the science of geology, especially as it relates to petroleum and natural gas; to promote the technology of petroleum and natural gas and improvements in the methods of winning these materials from the earth; to foster the spirit of scientific research amongst its members; to disseminate facts relating to the geology and technology of petroleum and natural gas; to maintain a high standard of professional conduct on the part of its members; and to protect the public from the work of inadequately trained and unscrupulous men posing as petroleum geologists. (Constitution, Article II.)

CODE OF ETHICS

ARTICLE I. GENERAL PRINCIPLES

SECTION 1. The practice of petroleum geology is a profession. It is the duty of those engaged in it to be guided by the highest standards of professional conduct and to subordinate reward and financial gain thereto.

SEC. 2. The confidence of the public and of the oil industry can be won and held only by the practice of the highest ethical principles.

SEC. 3. Honesty, integrity, fairness, candor, fidelity to trust, inviolability of confidence, and conduct becoming a gentleman are incumbent upon every member of this Association.

ARTICLE II. RELATION OF GEOLOGIST TO PUBLIC AND PROFESSION

SECTION 1. A geologist should avoid and discourage sensational, exaggerated, and unwarranted statements, especially those that might induce participation in unsound enterprises.

SEC. 2. A geologist should not knowingly permit the publication of his report or maps for the purpose of raising funds without legitimate and sound development in view.

SEC. 3. A geologist may accept for his services in the making of a report an interest in the property reported on, but it is desirable that the report state the fact of the existence of the interest.

SEC. 4. A geologist should not give an opinion or make a report without being as fully informed as might reasonably be expected, considering the purpose for which the information is desired. The opinion or report should make clear the conditions under which it is made

SEC. 5. A geologist may publish simple and dignified business, professional, or announcement cards, but should not solicit business by other advertisements, or through agents, or by furnishing or inspiring exaggerated newspaper or magazine comment. The most worthy advertisement is a well-merited reputation for professional ability and fidelity. This cannot be forced, but must be the outcome of character and conduct.

ARTICLE III. RELATION OF GEOLOGIST TO EMPLOYER

SECTION 1. A geologist should protect, to the fullest extent possible, the interests of his employer so far as consistent with the public welfare and his professional obligations.

SEC. 2. A geologist who finds that his obligations to his employer conflict with his professional obligations should notify his employer of that fact. If the objectionable condition persists, the geologist should sever his connection with his employer.

SEC. 3. A geologist should not allow himself to become or remain identified with any enterprise of questionable character.

SEC. 4. A geologist should make known to his prospective employer any oil or gas interests which he holds in the region of his prospective employment.

SEC. 5. A geologist, while employed, should not directly or indirectly acquire any present or prospective oil or gas interest without the express consent of his employer.

SEC. 6. A geologist retained by one client should, before accepting engagement by others, notify them of this affiliation, if in his opinion the interests might conflict.

SEC. 7. A geologist who has made an investigation for a client should not, without the client's consent, seek to profit from the economic information thus gained, or report on the same subject for another client, until the original client has had full opportunity to act on the report.

SEC. 8. A geologist should not accept direct or indirect compensation from both buyer and seller without the consent of both parties; or from parties dealing with his employer without the employer's consent.

SEC. 9. A geologist should observe scrupulously the rules, customs, and traditions of his employer as to the use or giving out of information or the acquisition of interests, both while employed and thereafter; and, except as permitted by such rules, customs and traditions or by the consent of the employer he should not seek to profit directly or indirectly from the economic information gained while so employed.

SEC. 10. A geologist employed by a state geological survey should not permit private professional work or the holding of private mineral interests in the state to interfere with his duty to the public or to lessen the confidence of the public in the survey. The preferable course is to avoid such private work and interests.

SEC. 11. A geologist should not divulge information given him in confidence.

ARTICLE IV. RELATION OF GEOLOGIST TO OTHER GEOLOGISTS

SECTION 1. A geologist should not falsely or maliciously attempt to injure the reputation or business of a fellow geologist.

SEC. 2. A geologist should not knowingly compete with a fellow geologist for employment by reducing his customary charges.

SEC. 3. A geologist should give credit for work done to those, including his assistants, to whom the credit is due.

ARTICLE V. DUTY TO THIS ASSOCIATION

SECTION 1. Every member of the Association should aid in preventing the election to membership of those who lack moral character or the required education and experience.

SEC. 2. A member of this Association who has definite evidence of the violation of the established principles of professional ethics by another should report the facts to the executive committee.

Respectfully submitted,

CHARLES E. DECKER, *Secretary*

A MID-YEAR MEETING IN 1924

At the close of the annual meeting in Houston there was held a rather full discussion on the matter of the mid-year meeting for 1924. The general committee had recommended that a mid-year meeting be held in either New York or Washington, and the executive committee desired full details as to the desires of members who are resident in those cities and who would be called on necessarily to assist materially with the arrangements and program. In the final analysis we found some obstacles in the way of having the meeting at either place. The feeling is that when we do have a meeting in New York we should cover foreign fields rather fully, and ask certain geologists from other countries to participate in the program. It is believed that the time is not sufficient to work up such a program by fall; that we should have at least a twelve months' period in which to prepare and carry out plans completely for the foreign papers. A number of members have suggested that it will be well to let the New York meeting go over for a regular annual meeting sometime in New York to cover oil fields outside the United States. Our best contact with such fields is undoubtedly in New York, where we have a membership willing and anxious to put over such a program as outlined. The Association needs to assemble such papers eventually.

As regards Washington, we found that the members of the Association on the United States Geological Survey do not get back to Washington from field work until October and that they should be there at least thirty days before the meeting. This would push the meeting into November, which is a little late in the year and at a time when arrangements for the annual meeting are getting under way.

The conditions as above outlined caused the executive committee to reconsider the matter of having a mid-year meeting in 1924. The two previous mid-year meetings were held to fill urgent calls and needs, and the precedent was established to that extent only.

Moreover, our editor has in his hands sufficient material to supply the forthcoming bulletins until the next annual meeting. Therefore the executive committee has called off the mid-year meeting. We have substituted for the meeting, however, a general invitation to members to attend the International Petroleum Exposition in Tulsa, October 2–11, inclusive, at which time the Tulsa geologists will arrange a program of entertainment for visiting geologists and their wives. It is thought best to make this a purely entertaining program. You who are golf hounds may be entered in a tournament at that time, which would close out at the dinner and evening entertainment at which the artistic talents of certain members can again be expressed. We want you to come in the same spirit as the red-headed boy who sang, "When they strike oil on my daddy's farm." The Exposition bids fair to far eclipse the last one, which itself met with extended approval. It will be well worth your time and the expense to see it and we trust you will lay your plans accordingly.

JAMES H. GARDNER, *President*

MEMBERSHIP APPLICATIONS APPROVED FOR PUBLICATION

The executive committee has approved for publication the names of the following applicants for membership in the Association. This publication does not constitute an election, but places the names before the membership at large. In case any member has information bearing on the qualifications of these applicants, please send it promptly to Charles E. Decker, Norman, Oklahoma.

(Names of sponsors are placed beneath the name of each applicant.)

FOR FULL MEMBERSHIP

William C. Adams, Tulsa, Oklahoma
J. Elmer Thomas, Alexander Deussen, George Sawtelle
Donald S. Birkett, Buenos Aires, Argentina
Eugene Stebinger, K. D. White, Albert O. Hayes
Silas P. Borden, Shreveport, Louisiana
J. P. D. Hull, A. F. Crider, David Donoghue
Ira Otho Brown, Tulsa, Oklahoma
Sidney Powers, C. R. Thomas, D. S. Hager
George H. Chadwick, San Antonio, Texas
E. P. Hindes, I. C. White, Sidney Powers
Drue D. Christner, Dallas, Texas
Hal P. Bybee, J. A. Udden, E. H. Sellards

Melvin J. Collins, Dallas, Texas
Clarence E. Hyde, Joseph M. Perkins, Walter R. Berger
Joseph A. Cushman, Sharon, Massachusetts
F. Park Geyer, F. L. Aurin, K. C. Heald
John W. Finch, Denver, Colorado
C. A. Fisher, Thomas S. Harrison, Charles M. Rath
Horace L. Griley, El Dorado, Kansas
Howard Clark, Rudolf R. Uhrlaub, Frank Carney
George L. Harrington, Buenos Aires, Argentina
Eugene Stebinger, K. D. White, Albert O. Hayes
Henry J. Hawley, San Francisco, California
G. C. Gester, S. H. Gester, R. C. Stoner
Harry Hotchkin, Tulsa, Oklahoma
Frank C. Greene, T. K. Harnsberger, R. A. Conkling
Arthur H. Howard, London, England
Sidney Powers, L. Murray Neumann, E. DeGolyer
James H. Jenkins, Fort Worth, Texas
James V. Howe, E. W. McCrary, F. M. Hutchinson
Coy B. Jones, Kingston, Oklahoma
Clarence E. Hyde, E. W. Ames, D. W. Ohern
William Weaver Keeler, Tulsa, Oklahoma
Luther H. White, V. H. McNutt, V. H. Hughes
Edmondson D. Luman, Tulsa, Oklahoma
R. B. Whitehead, Paul L. Applin, R. A. Steinmayer
Ernest Marquardt, Casper, Wyoming
Frederick G. Clapp, E. L. Estabrook, Max W. Ball
Gilbert P. Moore, Columbia, Missouri
Eugene Stebinger, K. D. White, Albert O. Hayes
John Bowen Orynski, San Francisco, California
O. A. Cavins, G. C. Gester, R. C. Stoner
Leroy T. Patton, Austin, Texas
C. W. Shannon, J. A. Udden, E. H. Sellards
Frank E. Poulsen, Mexia, Texas
A. F. Morris, C. W. Tomlinson, A. A. Langworthy
Thomas M. Prettyman, Houston, Texas
R. F. Baker, Wallace E. Pratt, F. C. Sealey
George B. Richardson, Washington, D.C.
W. C. Mendenhall, P. V. Roundy, David White
George B. Sammons, Toronto, Canada
Erasmus Haworth, H. E. Crum, R. C. Moore
William W. Sheldon, Tulsa, Oklahoma
Luther H. White, Robert H. Wood, M. J. Munn
George W. Snider, Tulsa, Oklahoma
L. Murray Neumann, A. W. Lauer, Sidney Powers

Lewis G. Weeks, London, England
    D. Dale Condit, Frank B. Notestein, R. V. Anderson
Niles B. Winter, Shreveport, Louisiana
    R. B. Whitehead, L. P. Teas, E. V. Woolsey

FOR ASSOCIATE MEMBERSHIP

Ray B. Anderson, Louisville, Kentucky
    Samuel Caudill, W. H. Foster, J. W. Merritt
A. C. Bace, Houston, Texas
    Samuel Weidman, D'Arcy M. Cashin, Wallace E. Pratt
Erdice R. Bockway, Marshall, Illinois
    S. Weidman, A. J. Williams, O. F. Evans
Merle Q. Dannettell, Denver, Colorado
    Charles T. Lupton, Charles M. Rath, Harold T. Morley
Rhydon B. Grigsby, Baton Rouge, Louisiana
    Henry V. Howe, A. F. Crider, C. L. Moody
Merle F. Gunby, Buffalo, Kansas
    S. Weidman, V. E. Monnett, O. F. Evans
Russell H. Gwinner, El Dorado, Arkansas
    Roswell H. Johnson, R. E. Somers, Ralph E. Davis
Robert B. Harkness, Toronto, Canada
    Ralph E. Davis, James H. Hance, Walter J. Allen
Francis E. Heath, San Antonio, Texas
    Roswell H. Johnson, R. E. Somers, W. B. Moyer
Harold H. Henderson, Austin, Texas
    Hal P. Bybee, F. L. Whitney, E. H. Sellards
Charles S. Lavington, Denver, Colorado
    E. Russell Lloyd, E. M. Parks, Charles M. Rath
Junius Henderson, Boulder, Colorado
    C. A. Fisher, Thomas S. Harrison, Charles M. Rath
Harold N. Hickey, Golden, Colorado
    F. M. Van Tuyl, C. A. Fisher, Charles M. Rath
Paul B. Hunter, Dallas, Texas
    Clarence E. Hyde, F. Park Geyer, F. L. Aurin
E. B. Hutson, Apple Springs, Texas
    Hal P. Bybee, F. L. Whitney, E. H. Sellards
Donald Kelley, Lincoln, Nebraska
    Erwin H. Barbour, E. F. Schramm, S. Weidman
John K. M. King, Baton Rouge, Louisiana
    Henry V. Howe, A. F. Crider, C. L. Moody
Edward H. McCollough, Houston, Texas
    G. E. Anderson, S. Weidman, O. F. Evans
Carroll C. Miller, Cromwell City, Oklahoma
    R. S. Knappen, C. S. Corbett, G. E. Anderson

Edward F. Miller, Cordell, Oklahoma
Charles C. Hoffman, Joseph Jensen, L. C. Snider
Walter W. Morris, Henryetta, Oklahoma
James H. Gardner, Robert H. Dott, Luther H. White
Charles H. Pishny, Ponca City, Oklahoma
K. C. Heald, F. L. Aurin, J. V. Howell
Cyrus C. Robbins, Pittsburgh, Pennsylvania
Ralph E. Davis, Eugene A. Stephenson, James H. Hance
James R. Seitz, Billings, Oklahoma
Clarence E. Hyde, Wallace C. Thompson, V. E. Monnett
Erwin W. Smith, Houston, Texas
John R. Suman, Wallace E. Pratt, David Donoghue
Joe P. Smith, Baton Rouge, Louisiana
Henry V. Howe, A. F. Crider, C. L. Moody
Alfred H. Sorensen, Ord, Nebraska
E. F. Schramm, Edwin H. Barbour, A. J. Williams
William H. Spice, Jr., San Antonio, Texas
Clarence E. Hyde, Walter R. Berger, F. L. Aurin
Harold H. Tillotson, Norman, Oklahoma
Samuel Weidman, V. E. Monnett, A. J. Williams
Herbert J. Weeks, Dallas, Texas
Charles H. Row, Wallace C. Thompson, W. H. Twenhofel
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Hal P. Bybee, F. L. Whitney, E. H. Sellards
Stanley B. White, Tulsa, Oklahoma
J. C. Ross, O. M. Edwards, R. S. McFarland
Paul A. Whitney, Tulsa, Oklahoma
Burr McWhirt, Karl H. Schilling, T. K. Harnsberger
Elvis B. Whitwell, Norman, Oklahoma
A. F. Morris, F. L. Aurin, J. L. Tatum
Francis S. Williams, Lincoln, Nebraska
E. F. Schramm, Erwin H. Barbour, A. W. Lauer
Everett A. Wyman, Lincoln, Nebraska
Erwin H. Barbour, E. F. Schramm, S. Weidman
Charles E. Yager, Jr., Wynnewood, Oklahoma
John R. Suman, W. F. Bowman, Wallace E. Pratt

FOR TRANSFER FROM ASSOCIATE TO FULL MEMBERSHIP

Frank E. Eckert, Pittsburgh, Pennsylvania
Roswell H. Johnson, I. C. White, Eugene A. Stephenson
Fred K. Foster, Lincoln, Nebraska
E. F. Schramm, Charles T. Kirk, George C. Matson

Laurence Charles Hay, Independence, Kansas
Henry A. Ley, R. C. Moore, R. S. Knappen
Morton T. Higgs, Dallas, Texas
H. W. Peabody, H. Harper McKee, A. L. Beekly
Malvin G. Hoffman, Tulsa, Oklahoma
W. E. Wrather, Earl A. Trager, Charles N. Gould
Phillip Maverick, San Antonio, Texas
R. F. Baker, F. C. Sealey, H. T. Kniker
Charles H. McNeese, Ponca City, Oklahoma
Clarence E. Hyde, F. L. Aurin, Walter R. Berger
Ray F. Schoolfield, Shreveport, Louisiana
Wallace C. Thompson, J. P. D. Hull, Angus McLeod

REGIONAL DIRECTORS

The following men have been selected as regional directors of the Association for the current year:

For the Eastern Territory, Mr. Ed. DeGolyer, 65 Broadway, New York, New York.

For the Mid-Continent Region, Mr. A. F. Crider, 821 Ontario Street, Shreveport, Louisiana.

For the Gulf Coast, Mr. David Donoghue, West Building, Houston, Texas.

For the Rocky Mountain Region, Mr. Thomas S. Harrison, 1106 First National Bank Building, Denver, Colorado.

For the Pacific Coast, Mr. Frank S. Hudson, 900 Title Insurance Building, Los Angeles, California.

The membership will look to these men to further the interests of the Association in every way possible in their respective territories. They will be in correspondence from time to time with the executive officers in advancing the usefulness and growth of the Association.

The Regional Directors have proved to be a great benefit, particularly in the matter of working up good papers for the Annual Meeting, and it is hoped that this year they will lay especial emphasis on promoting research in their respective districts with the idea of having results of various observations and experiments given at the next Annual Meeting. However, good papers are desired, as usual, on the various subjects of interest to petroleum geology throughout the United States and foreign countries.

James H. Gardner, *President*

DISTRIBUTION OF MEMBERSHIP IN THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

Taking the list of members of the American Association of Petroleum Geologists, published in the January-February number of this volume, Richard Hughes, of Tulsa, has made inquiry into the geographic distribution as shown

by the more or less permanent addresses given of these members. His findings, showing the number of members in cities having ten or more Association geologists, may be tabulated as follows:

Tulsa, Okla.	123	Dallas, Tex.	26
Houston, Tex.	39	Washington, D.C.	26
Los Angeles, Cal.	34	Oklahoma City, Okla.	22
Denver, Colo.	31	San Francisco, Cal.	12
New York City.	29	Fort Worth, Tex.	11
Shreveport, La.	27	Okmulgee, Okla.	10

These numbers are doubtless only partially indicative of the actual distribution in the larger centers, for the addresses given in the membership list are in many instances those of the company headquarters and not the places where the geologists are chiefly engaged. This probably makes the tally for Tulsa, for example, considerably too high, and the same may be true in other cases. There are only about 100 members in the Tulsa Geological Society, and membership in this society includes anyone who pays the dues of two dollars a year, whether he is a geologist, assistant, newspaper man, or what not. There are assuredly less than 100 members of the Association who spend most of their time in this mid-continent oil capital. Also it appears that our membership in some centers, such as San Francisco, is lower, according to this tabulation, than it should be.

Addresses in Oklahoma are listed for 312 members; in Texas, for 140 members; in California, for 99 members; and in Kansas, for 52 members. In the Rocky Mountain states there are 99 geologist members of the Association, and in the states east of the Mississippi, 187. Many members are engaged in foreign work and are in part not included in this summary; others are listed from the city of their permanent American headquarters, especially in the case of New York.

While the figures set down are subject to numerous corrections and qualifications as regards conclusions on the actual distribution of the Association membership, it is interesting to inquire how closely this distribution represents the application of geology in the different oil-producing regions of the country, and how far it indicates the relative importance of the various districts. At the present time the membership in the American Association is very largely representative of geology in the petroleum industry. The organization and its interests are truly national, or rather international, in scope. Yet there would appear to be in certain quarters room for possible enlargement by the addition of desirable members.

RAYMOND C. MOORE

CERTIFICATE OF INCORPORATION OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

KNOW ALL MEN BY THESE PRESENTS, That we, Charles E. Decker, Max W. Ball, and Charles M. Rath, being all persons of full age and citizens of the United States, desiring to form a corporation in pursuance of the provisions of

Sub. Div. XII, chapter xxxviii, Compiled Laws of Colorado, 1921, into which corporation an existing unincorporated association known as THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS may be merged, do hereby make, execute, and acknowledge, in duplicate, this certificate in writing of our intention so to become a body corporate under and by virtue of said laws, which certificate, when filed with the secretary of state of the state of Colorado, shall constitute the articles of incorporation of our said corporation, and we do certify as follows:

1. The corporate name and style of our said corporation shall be the name now belonging to the aforesaid unincorporated association, that is to say, THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS.

2. The objects and purposes for which this corporation is formed are to promote the science of geology in general, but more especially with reference to its application to the discovery and production of petroleum and natural gas; to promote the technology of petroleum and natural gas; to foster a spirit of scientific research among its members; to maintain a high standard of professional conduct on the part of its members; to protect the public from imposition by inadequately trained or unscrupulous persons; and to promote social intercourse among its members.

In order to accomplish its objects and purposes, the corporation shall have power to hold meetings for social intercourse and the reading and discussion of professional papers; to circulate among its members, by means of publications or otherwise, the information obtained by this or other means; to provide for the organization and continuation of subordinate branches, either within or outside of the state of Colorado, and either within or outside of the United States of America; to hold meetings of its members, and of its managers, either within or outside of the state of Colorado, and either within or outside of the United States of America; to have offices outside of, as well as within, the state of Colorado; to construct, maintain, buy, own, sell, and to rent from others, or to others, such buildings and offices as may, to the executive committee of the corporation, appear desirable in order to accomplish any of its objects and purposes; to provide what qualifications shall be necessary for membership; to provide a classification of membership into two or more classes and the conditions to be attached to each class; to provide the method of electing members; to admit or exclude any person; to expel any person from membership; to provide the conditions under which membership will be forfeited; to provide that membership may be forfeited for non-payment of dues without giving of notice; to provide, and to aid in providing, such entertainment, from time to time, as to the executive committee may appear desirable; to make such prudential by-laws as its members may deem proper in order to accomplish the objects and purposes of the corporation, which by-laws may be divided into two parts, one part to be known as the "Constitution" and the other part to be known simply as "By-Laws," either of which may be adopted, amended, or repealed in accordance with the provisions thereof; and to do any and all other

things, and to take any and all other steps, which may be lawfully done or taken by corporations organized under said Sub. Div. XII.

3. Unless its existence be sooner terminated, our said corporation is to exist for the term of twenty (20) years, and may renew its existence at the expiration of said term.

4. The affairs and management of said corporation are to be under control of five managers, to be known collectively as the executive committee, comprising such officers as by the constitution are from time to time made members of the executive committee, and the names of those selected as such managers of our corporation for the first year of its existence, unless the place of any of said managers should become vacant at an earlier time through death, resignation, or otherwise, are:

James H. Gardner
Earl G. Gaylord
Charles E. Decker
Raymond C. Moore
Max W. Ball

The principal office of our said corporation in the state of Colorado shall be located in the First National Bank Building, in the city and county of Denver, and the name of the agent in charge thereof is Max W. Ball.

IN TESTIMONY WHEREOF, We have hereunto set our hands and seals this 21st day of April, A.D. 1924.

(S) MAX W. BALL (*Seal*)
(S) CHARLES M. RATH (*Seal*)
(S) CHARLES E. DECKER (*Seal*)

STATE OF COLORADO }
City and County of Denver } ss.

I, Iris Stout, a Notary Public in and for said city and county and state do hereby certify that Charles E. Decker, Max W. Ball, and Charles M. Rath, personally known to me to be the persons whose names are subscribed to the annexed and foregoing CERTIFICATE OF INCORPORATION, appeared before me this day in person and acknowledged that they signed, sealed, and delivered the said instrument of writing as their free and voluntary act, for the uses and purposes therein set forth.

Given under my hand and Notarial Seal this 21st day of April, A.D. 1924.

My commission expires March 9, 1926.

(*Seal*) (S) IRIS STOUT, *Notary Public*

THE CONSTITUTION OF THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS

The following draft of the constitution of the Association contains new divisions recently approved by the membership.

Article I. Name

This Association shall be called "The American Association of Petroleum Geologists."

Article II. Object

The object of this Association is to promote the science of geology, especially as it relates to petroleum and natural gas; to promote the technology of petroleum and natural gas and improvements in the methods of winning these materials from the earth; to foster the spirit of scientific research amongst its members; to disseminate facts relating to the geology and technology of petroleum and natural gas; to maintain a high standard of professional conduct on the part of its members; and to protect the public from the work of inadequately trained and unscrupulous men posing as petroleum geologists.

Article III. Members

Section 1. Any person actively engaged in the work of petroleum geology or in research pertaining to petroleum geology or technology is eligible to active membership in the American Association of Petroleum Geologists, provided he is a graduate of an institution of collegiate standing, in which institution he has done his major work in geology, and in addition has had the equivalent of three years' field experience in petroleum geology; and provided further that in case of an applicant for membership who has not had the required collegiate or university training, but whose standing in the profession is well recognized, he shall be admitted to membership when his application shall have been favorably and unanimously acted upon by the executive committee; and provided further that these requirements shall not be construed to exclude instructors and professors in recognized institutions of learning whose work is of such character as in the opinion of the executive committee shall qualify them for membership.

Sec. 2. Any person having completed as much as thirty hours of geology (an hour shall here be interpreted as meaning as much as sixteen recitation or lecture periods of one hour each, or the equivalent in laboratory) in a reputable institution of collegiate or university standing, or who has done field work equivalent to this, shall be eligible to associate membership in the American Association of Petroleum Geologists, provided that at the time of his application for membership he shall be engaged in geological studies in an institution of collegiate or university standing, or shall be engaged in geological work.

Sec. 3. Active and associate members shall be elected to the Association according to the qualifications outlined in Sections 1 and 2, provided that the applicant properly fills out the regular application blank, including the signatures of *three* active members of the Association, and that such application be approved by at least three of the members of the executive committee of the Association, as provided for in Article IV, Sections 1 and 4.

Sec. 4. Associate members shall enjoy all privileges of membership in the Association, save that they shall not hold office, sign applications for mem-

bership, nor vote in business meetings; neither shall they have the privilege of advertising their associate membership in the Association in professional cards, nor shall they have the privilege of signing professional reports as associate members of the Association.

SEC. 5. Each applicant for membership shall formally be notified in writing by the secretary of his election, and shall be furnished with a membership card for the current year; and until such formal notice and card are received, he shall in no way be considered a member of the Association.

SEC. 6. Applications for membership may be accepted at any time, but unless an applicant shall have his application approved and have been formally notified by the secretary of his election at least one month before the annual meeting, he shall not be allowed to participate in the business of said annual meeting.

SEC. 7. The executive committee may from time to time elect as honorary members persons who have contributed distinguished service to the cause of petroleum geology. Honorary members shall not be required to pay dues, nor shall they be allowed to vote.

ARTICLE IV. OFFICERS

SECTION 1. The officers of the Association shall consist of a president, a vice-president, a secretary-treasurer, and an editor-in-chief. These together with the retiring president shall constitute the executive committee of the Association.

SEC. 2. The officers shall be elected annually from the Association at large.

SEC. 3. No man shall hold the office of president or vice-president for more than two years in succession.

SEC. 4. The executive committee shall consider all nominations for membership and pass on the qualifications of the applicant; shall have the control of the Association's work and property; shall determine the manner of publication, and pass on all materials presented for publication; and may call special meetings when and where thought advisable, and arrange for the affairs of the same.

SEC. 5. The officers elect shall assume the duties of their respective offices one month after date of election.

ARTICLE V. MEETINGS

The annual meetings shall be held at a time most convenient for the majority of the members at a place designated by the executive committee. At this meeting the election of members shall be announced, the proceedings of the preceding meeting be read, all society business transacted, scientific papers read and discussed, and officers for the ensuing year shall be elected.

ARTICLE VI. AMENDMENTS

This constitution may be amended at any time, providing that such amendment is proposed and signed by at least five members of the Association,

and is presented and discussed at any annual meeting of the Association. The secretary shall take a ballot of the membership by mail within thirty days after the meeting of the Association, and a majority vote of the ballots received shall be sufficient to amend, provided more than one-half of the members return ballots.

ARTICLE VII. PUBLICATION

The proceedings of the annual meeting and the papers read shall be published in an annual bulletin. This shall be under the immediate supervision of the editor-in-chief, assisted by associate editors whom he shall appoint in the various regions.

ARTICLE VIII. SECTIONS

SECTION 1. Regional sections of the Association may be established provided the members of such sections shall perfect a regional organization and make application to the executive committee, who shall submit the application to a vote at a regular annual meeting; a vote of two-thirds of the members present being necessary for the establishment of such a section, and provided that the Association may revoke the charter of any section by a vote of two-thirds of the membership.

BY-LAWS

SECTION 1. *Dues.*—The regular annual dues of an active member of the Association shall be $10.00. The annual dues of an associate member of the Association shall be $6.00. The annual dues are to be paid to the secretary-treasurer on or about January first for the year ending the following December.

SEC. 2. Any member who shall fail to pay his regular annual dues for a period of one year may be suspended by a vote of the executive committee, but may be reinstated upon the unanimous consent of the committee.

SEC. 3. The payment of the annual dues entitles the member to receive, without further charge, one copy of the proceedings of the Association for that year.

SEC. 4. Any member who shall be guilty of flagrant violation of the established principles of professional ethics may, upon the unanimous vote of the executive committee, be suspended or expelled from membership, provided that such person shall before suspension or expulsion be granted a hearing before the executive committee.

AMENDMENTS

These by-laws may be amended by the vote of three-fourths of the active members present at any annual meeting.

A NEW ADVERTISING MANAGER

Mr. William B. Heroy, 19 Wayne Avenue, White Plains, New York, has been appointed Advertising Manager for the Association, on the resignation of J. Elmer Thomas. Mr. Thomas has very successfully handled the matter of

advertising for the Association, but has found that his time does not permit of his carrying on the work farther.

Mr. Heroy has had experience which particularly qualifies him for handling such matters, and agreed to take the position, at least until the end of the year. By that time he will be able to have ascertained the details in connection with that office and determine whether or not his trips to distant points seriously interfere with carrying on the matter of advertisements for the *Bulletin*.

At the close of the Houston meeting, Mr. Heroy agreed to accept the appointment under the conditions above stated, and all communications with respect to advertisements should be directed to him at the address given.

CENTENARY OF THE FRANKLIN INSTITUTE

In response to an invitation from the president and members of the Franklin Institute to the American Association of Petroleum Geologists to have the Association represented at the Centenary of the foundation of the Institute, President Gardner has appointed Dr. Arthur Knapp, of Philadelphia, Pennsylvania, to represent the Association on that important occasion. Dr. Knapp has stated that he will be glad to be present in behalf of the Association, and will no doubt be asked to respond in some way in our behalf.

The Centenary will be held for three consecutive days, beginning Wednesday, September 17, 1924. If there are other members of the Association who can be present at that time, it is the request of Mr. Gardner that they get in touch with Arthur Knapp at some time previous to the celebration, in order that members of the Association present may gather together with him at that time.

AT HOME AND ABROAD

CURRENT NEWS AND PERSONAL ITEMS OF THE PROFESSION

J. M. WILSON, formerly with the Minerals Division of the Louisiana State Conservation Department at Shreveport, Louisiana, has resigned to become geologist for the Simms Oil Company, Magnolia Building, Dallas, Texas.

F. H. LAHEE, chief geologist of the Sun Company at Dallas, Texas, has recently returned from a trip lasting several months in South America.

K. C. HEALD, after a few days' field trip in Kansas, journeyed to Wyoming in April. Tea Pot Dome still steams.

LESLIE STEELE HARLOWE, of the geological department of the Louisiana Oil Refining Corporation, Shreveport, Louisiana, and Miss Virginia Williams, of Sullivan, Missouri, were married on April 2, 1924. Mr. and Mrs. Harlowe will make Shreveport their home.

H. W. C. PROMMEL, consulting geologist, of Denver, has just returned from an extensive study of geological conditions in Brazil, South America.

R. S. KNAPPEN is teaching Geology in the first term of summer school at the University of Utah.

H. E. CRUM, consulting geologist at Ottawa, Kansas, made a trip to the Pacific Coast in May, to aid in the installation of chapters of the geological fraternity Sigma Gamma Epsilon in Washington and California.

P. S. HOURY, formerly with the California Mining Bureau and recently located at Dallas, Texas, announces the opening of an office for consulting work in petroleum engineering and geology, Room 5 Odd Fellows Bldg., Taft, California.

E. RUSSELL LLOYD has opened offices at 1104 First National Bank Building, Denver, Colorado, as consulting geologist. Previously, Mr. Lloyd was associated with Max Ball in the Marine Oil Company.

At the fifth national convention of Sigma Gamma Epsilon, the professional geological, mining, and metallurgical fraternity at Golden, Colorado, April 18 and 19, officers elected to the grand council for the next biennium are: CHARLES E. DECKER, president; E. F. SCHRAMM, vice-president; C. B. CARPENTER, secretary-treasurer; W. A. TARR, editor; and C. A. BONINE, historian.

W. W. RUBEY and M. N. BRAMLETTE left Kansas in June to resume investigations for the United States Geological Survey of oil possibilities in the Black Hills region.

M. M. VALERIUS has moved his office from 327 Mayo Building to the Wilcox Building, Tulsa.

WOOD BROS. have moved their offices from 816 Daniels Building to 302 Commercial Building, Tulsa.

ALLEN C. TESTER, who has been completing graduate studies at the University of Wisconsin, will be engaged in field investigations during the summer for the State Geological Survey of Kansas.

The Oklahoma state legislature has appropriated funds for maintenance of the geological survey.

The Prairie Oil & Gas Co. has at last succumbed to the wiles of geology. LAWRENCE ("LARRY") OLES is in charge of reconnaissance work in northwestern Texas, with headquarters in Greenville.

FRED W. GARNJOST, of Spuyten Duyvil, New York, has spent the winter in Shreveport, Louisiana, as consulting engineer for one of the oil companies.

DONALD F. MACDONALD was in Shreveport, Louisiana, last March, reviewing geological and operating conditions in surrounding territory. Mr. MACDONALD has been on furlough from the Sinclair Oil Company during the past year in Southern Europe while recuperating from a severe attack of pneumonia contracted in the Balkans.

MARCUS I. GOLDMAN, of the United States Geological Survey, Washington, D.C., recently spent several days in Shreveport, Louisiana, collecting cap rock specimens to be used in his study of salt dome structures.

JOHN E. BRANTLY, of the Atlantic Refining Company, Philadelphia, Pennsylvania, stopped at the Shreveport, Louisiana, offices of the company, in March, en route to Mexico for a short stay. Mr. Brantly has been spending much time in South American countries during the last two years.

HAROLD K. SHEARER accepted a position in the geological department of the Standard Oil Company of Louisiana, at Shreveport, April 1, 1924. Mr. Shearer has been working in the Louisiana-Arkansas territory since 1919, with the exception of numerous trips to Central and South America.

J. P. D. HULL, of Shreveport, Louisiana, was elected president; V. V. WAITE, of Dallas, Texas, first vice-president; ANGUS MCLEOD, of Shreveport, Louisiana, second vice-president; H. P. BYBEE, of Austin, Texas, secretary; S. C. STATHERS, of Shreveport, Louisiana, treasurer; and F. L. WHITNEY, of Austin, Texas, and W. E. HOPPER, of Shreveport, Louisiana, members of council, of the Southwestern Geological Society, as announced at a meeting of the council, held at noon, March 27, 1924, at the University Club, Houston, Texas. The other members of council are L. J. PEPPERBERG, retiring president, of

Dallas; E. H. Sellards, of Austin; and E. W. Shuler, of Dallas, Texas. The Society has active local sections in Austin, Dallas, and Shreveport.

Edwin B. Hopkins, 25 Broadway, New York City, made a professional trip to New Mexico in April.

Clyde M. Bennett, vice-president of the Louisiana Oil Refining Corporation, Shreveport, was in New York City the latter part of March.

Ben K. Stroud, of the National Tube Company, Los Angeles, California, visited Shreveport, Louisiana, late in March.

Sidney Powers, Chief Geologist of the Amerada Petroleum Corporation at Tulsa, Oklahoma, was in Shreveport, Louisiana, in March and April, collecting first-hand evidence on old and new salt domes.

Frederick B. Plummer, geologist for the Rycade Oil Company at Houston, Texas, is giving a course of lectures in petroleum geology during the spring quarter at the University of Chicago.

Kenneth C. Heald, chief of the oil and gas section of the United States Geological Survey, has been appointed associate professor of geology at Yale University, with assignment to the Sheffield Scientific School. He will begin his work there in September.

J. H. Westby, formerly associated with Whitehall Petroleum Corporation, Ltd., in geologic work in Algeria, has taken up residence in California and is doing some research work, at present, with Robert Anderson at Stanford University.

Theo. A. Link is spending his second year in Columbia as geologist-in-charge for the Tropical Oil Company in the coastal area.

Robert V. Anderson of Menlo Park, California, returned to this country from Africa early this year. During most of last year he was in North Africa engaged in geological work. Anderson recently resigned his position as director of the Whitehall Petroleum Corporation, Ltd., of London (same as S. Pearson and Son, Ltd.) in order to make his home in California and engage in research work. He will continue to supervise the geologic work of the Whitehall Petroleum Corporation, Ltd., on a part-time basis.

R. M. Barnes, recently resigned his position as deputy state oil and gas supervisor for California, with headquarters at Coalinga, and has a position as subsurface engineer on the geological staff of the Marland Oil Company of California, with offices at 200 Bush Street, San Francisco.

Reed D. Bush, formerly superintendent of operations for Empire Gas & Fuel Company at El Dorado, Kansas, is now State Oil & Gas Supervisor for California, succeeding Roy E. Collom, resigned. Bush was formerly connected

with the department of petroleum and gas, which he now heads, as chief deputy under R. P. McLaughlin.

CARL H. BEAL has been recently made first vice-president of the Marland Oil Co. of California, with headquarters at 200 Bush Street, San Francisco. Beal has been closely identified with Marland operations for some time, having recently completed an extended geological survey along the west coast of Mexico and Lower California.

G. C. GESTER, chief geologist of foreign department of the Standard Oil Company of California, is on an extended exploration trip in South America.

RALPH D. REED recently completed his advanced work at Stanford University and received his doctor's degree. Reed is now engaged in geological field work for the Marland Oil Company of California.

WALTER STALDER, consulting petroleum geologist, of San Francisco, has been appointed chairman of the minerals committee of the Commonwealth Club of San Francisco and through this committee has initiated an investigation of various problems related to conservation of petroleum and gas in California.

GEORGE BURTON, of the Humble Oil Company, has been transferred from Holdenville to the Ardmore District.

SAM WELLS has been appointed district geologist for the Roxana Petroleum Corporation in the Okmulgee District.

C. A. WARNER made a very interesting talk on sand correlations in 10-8, 9-9, and the Southwest Okmulgee District to the Okmulgee Oil & Gas Association on March 15.

T. C. THOMPSON, formerly of the Roxana Petroleum Corporation, has accepted a position with the Indian Territory Illuminating Company, with headquarters at Bartlesville.

D. A. GREEN, formerly with the Roxana Petroleum Corporation, has accepted a position with the Pure Oil Company, with headquarters at Tulsa.

HENRY A. LEY, for the past two years chief geologist of the Southwestern Gas Company, of Independence, Kansas, has resigned his position to accept another as chief geologist of the Skelly Oil Company.

D. K. GREGER has resigned his position as paleontologist for the Roxana Petroleum Company at the Tulsa office. He has returned to New York City to take a similar position with the Standard Oil Company of New Jersey.

J. W. BEEDE has gone to Texas to become geologist for the Texas division of the Dixie Oil Company. Dr. Beede was formerly with the Empire Refining Co.

W. B. WILSON, chief geologist for the Gypsy Oil Company, is in Colorado for a few weeks looking after Gypsy Oil Company interests.

ALAN BRUYERE, formerly geologist for the Mexican division of the Texas Company, is spending some time looking after Texas Company interests in Kansas.

LUTHER H. WHITE, chief geologist for the J. Arthur Hull Oil Company, was a Tulsa delegate to the national convention of the Co-operative League, which recently convened in Louisville, Kentucky.

MYRON A. DRESSER returned to the United States last fall after three years' work in South America. While here, he married, and has now returned to South America with his bride. He is working out from Comodoro, Pategonia.

CHARLES W. STUDT has been appointed chief geologist for the Southwestern Gas Company of Independence, Kansas.

EDWIN B HOPKINS has just returned from consulting work in Venezuela, South America, and has taken up his duties in his New York office.

CORRECTION

In reporting a meeting of the Southwestern Geological Society, Dallas section, and the election of officers for that section, it was implied in the last number of the *Bulletin* that the meeting and the election of officers represented the entire Society. Mr. J. P. D. HULL, of Shreveport, Louisiana, is president of the Society, and the previously published report refers only to the Dallas section.